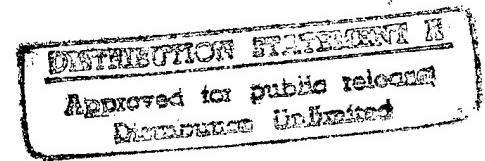


US Army Corps of Engineers Europe Division

**Energy Engineering Analysis Program
(EEAP) Study**

**Gruenstadt Depot Facilities
AAFES Europe, Germany
DACA90-87-R-7519
25 JUNE 1990**

EXECUTIVE SUMMARY



Volume 1 of 1

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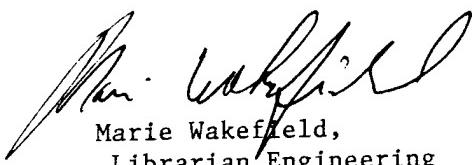


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EEAP - GRUENSTADT DEPOT, AAFES EUROPE

EXECUTIVE SUMMARY

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CORRECTIONS FOR INSERTION

NOTE TO ALL HOLDERS OF GRUENSTADT DEPOT EEAP FINAL REPORT:

THE ATTACHED PAGES CONTAIN CORRECTIONS TO THE FINAL REPORT. PLEASE INSERT THE FOLLOWING PAGES 1-1 THROUGH 1-7 (ENTITLED "PROJECT ABSTRACT") IN YOUR COPY (COPIES) OF THE REPORT.

1.1 INTRODUCTION

The purpose of this study is to develop a systematic plan to reduce energy consumption and associated costs for the major buildings at Gruenstadt Depot, including Buildings 3555, 3556, 3559, 3571, and 3571A, shown on Figure 1.1.1. This study is provided for the U. S. Army Corps of Engineers, European Division, to meet the requirements of the Energy Engineering Analysis Program (EEAP).

1.2 FACILITY DESCRIPTION

AAFES operates a production facility which produces baked goods, ice cream, and butchered meat products primarily for United States troops and dependents in Europe. This depot facility is located in Gruenstadt, Republic of West Germany.

The Gruenstadt Depot Facility consists of approximately 380,000 square feet of production and support buildings, as shown in the site plan of Figure 1.1.1 (attached to this Appendix). The facility is under the jurisdiction of the U. S. Army Military Community Activity in Worms, which is part of the 21st Theatre Army Area Command.

The bakery, ice cream plant, meat processing plant, and cold storage areas are located in the two-story Building 3555. This is the largest building on site, with 240,000 square feet, and is where most of the energy saving opportunities exist. This building and many of the other buildings on site were originally built in the 1950's. Construction for this building and many of the other buildings on site typically consists of uninsulated concrete block walls, foam insulated roof and single pane glass.

In 1982, the northwest portion of the two-story building 3555 was completely renovated to accomodate production of bread, rolls and sweet goods. Administrative areas were also remodeled.

Buildings on site are generally heated with steam. Ammonia refrigeration systems serve cold storage areas. Buildings are generally not air conditioned, with the exception of a few administrative areas. Within the last 5 years, some of the steam radiator heating systems have been converted to hot water radiator heating systems. Some insulation has been added to walls, single pane windows have been replaced with double pane windows. In 1986 a new boiler plant was built to provide steam for the site.

The general condition of the building construction varies from poor in some of the original cold storage areas to good in some of the recently remodeled administration and cold storage areas. The steam boiler plant is in excellent condition. The building steam heating systems installed in the 1950's in some areas are in poor condition. Hot water systems installed 1982 or later are in excellent condition. The buried site steam piping serving Building 3555 has been replaced since 1982. The buried steam piping serving Building 3559 was installed in the 1950's and should be replaced. More comprehensive descriptions of the condition of the building construction, mechanical systems, electrical systems and processes are found in Sections 2 and 3 of the Energy Analysis report.

The production and administration areas of the facility operate primarily five days per week. The bakery and ice cream plant will sometimes operate on Saturdays.

Energy conservation activities are on-going at the depot facility, as evidenced by energy awareness posters in administration areas and year-to-date energy consumption graphs on the exterior wall of the boiler plant. Maintenance and boiler personnel manually shut off heating and ventilating equipment during unoccupied or non-production hours to reduce energy consumption.

1.3 PROGRAMMING OVERVIEW

Energy conservation opportunities (ECO's) which are economically feasible fall under one of the following five categories:

<u>CATEGORY</u>	<u>CRITERIA</u>
O & M	Less than \$10,000 initial cost, payback less than 8 years.
QRIP	Between \$3000 and \$100,000 initial cost; payback less than 2 years
PECIP	Between \$3000 and \$100,000 initial cost; payback less than 4 years
OSD PIF	Over \$100,000 initial cost.
ECIP	Over \$200,000 initial cost.

1.4 LIST OF RECOMMENDED ECO'S

Refer to table 1.4.1 (attached to this Appendix) for a list of all ECO's recommended for implementation, including applicable funding category, annual energy savings, annual dollar savings, SIR, simple payback, and project cost.

1.5 CONCLUSIONS

A total of 147 energy conservation opportunities (ECO's) were evaluated for the buildings studied at this facility. Of these ECO's, 15 projects were found to be economically feasible.

An ECO is considered to be ecomonically feasible if it has an SIR greater than 1, and if it has a simple payback of 4 years or less. An additional 11 ECO's with slightly higher paybacks, and which do not qualify for funding, are recommended to be performed by facility operating personnel.

The annual utility costs for the facility are as follows:

Electricity	\$1,176,801
Natural Gas	\$ 316,473
Water	\$ 189,100
Total	\$1,682,374

Implementation of all economically feasible ECO's, including ECO's which can be performed by facility operating personnel will reduce utility costs by \$272,842 per year. This is a 16.2% reduction in overall utility costs.

The total initial cost of these recommended ECO's is \$633,680.

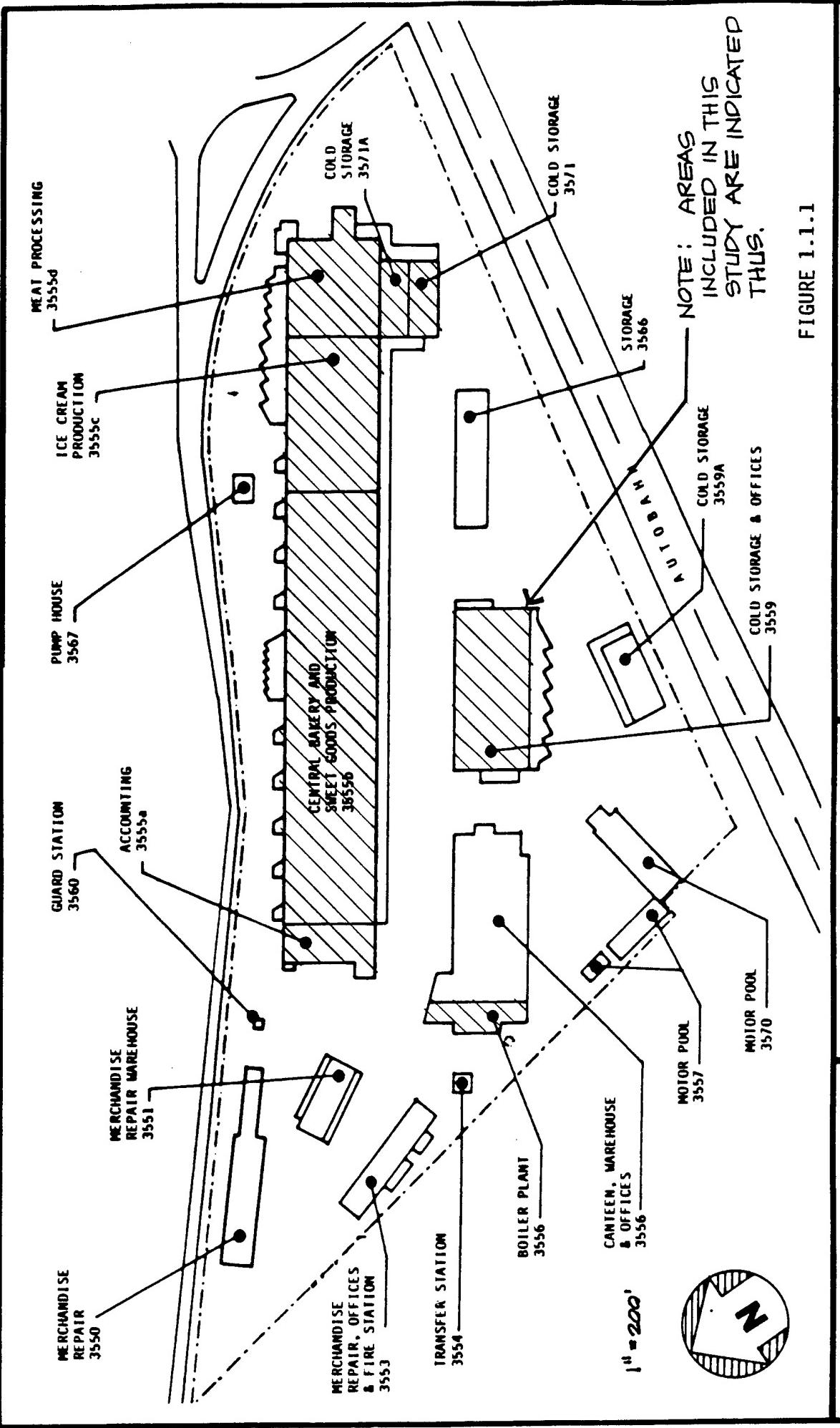


FIGURE 1.1.1

TABLE 1.4.1- LIST OF RECOMMENDED ECO'S

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	SIR	GAS SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY	TOT ENERGY SAVINGS \$/YR	NON-ENERGY SAVINGS \$/YR	TOTAL SAVINGS \$/YR
REDUCE INFILTRATION-VESTIBULE	3555c	55c-B-12	1.9	5.9	0	0	481.0	11097	21464	QRIP	11097	0	11097
INSULATE DOMESTIC HOT WATER TANKS	3555c	55c-H-18	6.1	2.8	160	680	0.0	0	4157	0 & H	680	0	680
INSULATE DOMESTIC HOT WATER PIPING	3555c	55c-H-20	6.1	2.8	42	179	0.0	0	1085	0 & H	179	0	179
STEAM SYSTEM MODIFICATIONS	3555b	55b-H-22	6.4	2.6	105	786	0.0	0	5059	0 & H	786	8	794
INSULATE STEAM PIPING	3555c	55c-H-22	1.4	11.8	621	2639	0.0	0	3764	QRIP	2639	0	2639
PROVIDE CONDENSATE RETURN	3555c	55c-H-23	5.5	2.7	165	701	-0.2	-5	6585	0 & H	696	495	1191
REPLACE STEAM TRAPS	3555b	55b-H-24	1.3	13.2	328	1394	0.0	23	1783	0 & H	1417	0	1417
REPLACE STEAM TRAPS	3555c	55c-H-24	1.3	13.2	164	697	0.0	0	891	0 & H	697	0	697
REPLACE STEAM TRAPS	3555d	55d-H-24	0.4	40.3	842	3579	0.0	0	1498	0 & H	3579	0	3579
INSULATE PIPING SPECIALTIES	3556	56-H-30	5.3	3.2	189	803	0.0	0	4255	0 & H	803	0	803
CONTROL MODIFICATIONS	3555b	55b-H-31	2.2	7.7	2706	11501	0.0	0	25253	PECIP	11501	0	11501
RADIATOR CONTROL VALVES	3555c	55c-H-31	4.2	4.0	133	565	0.0	0	2380	0 & H	565	0	565
RADIATOR CONTROL VALVES	3559	59-H-31	3.4	4.2	386	1641	82.0	1894	11897	PECIP	3535	0	3535
DA CONTROL DAMPERS	3555b	55b-H-33.2	4.9	3.4	462	1964	0.0	0	9708	0 & H	1964	0	1964

TABLE 1.4.1- LIST OF RECOMMENDED ECO'S

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY	TOT ENERGY SAVINGS \$/YR	TOTAL SAVINGS \$/YR		
REFRIGERANT PUMPS	3555b	55b-M-35.2	2.6	4.4	0	0	612.0	14119	35609	PECIP	14119	-400	13719
PROCESS EVAPORATIVE COOLER	3555c	55c-M-35.1	1.9	6.3	0	0	-77.0	-1774	41330	ORIP	-1774	24000	22226
NEW REFRIGERATION CENTRAL CONTROL	3555c	55c-M-35.3	3.5	3.3	-1	-6	3091.0	71309	283909	ECIP	71303	10400	81703
CYCLE REFRIGERATION SPACE COOLERS	3555c	55c-M-35.4	0.8	13.8	-27	-113	2501.0	57698	47880	ORIP	57585	0	57585
INSULATE REFRIGERATION COMPRESSORS	3555c	55c-M-35.7	1.7	6.7	0	0	138.0	3184	5450	ORIP	3184	0	3184
NEW REFRIGERATION INTERCOOLER	3555c	55c-M-35.8	1.1	10.9	1942	44802	1942.0	44802	47229	ORIP	89604	0	89604
NEW REFRIGERATION OIL SEPARATOR	3555c	55c-M-35.11	1.0	11.2	0	0	270.0	6229	6395	ORIP	6229	0	6229
HVAC COOLING SYSTEM MODIFICATIONS	3555d	55d-M-35	3.3	3.4	0	0	165.0	3807	12043	PECIP	3807	-200	3607
DOMESTIC WATER PREHEAT-DESUPERHEATERS	3555b	55b-M-37.6	3.8	4.5	810	3443	0.0	0	12705	PECIP	3443	-80	3363
PROVIDE TIME CLOCKS-LIGHTING CONTROL	3555a	55a-E-45.2	7.9	1.5	0	0	29.0	678	5378	0 & M	678	0	678
PROVIDE TIMECLOCK LTC. CONTROLS	3555b	55b-E-45.1	1.5	7.3	-137	-582	309.0	7129	9812	ORIP	6547	0	6547
REPLACE FLOOR. BALLASTS - ADD TIMERS	3555b	55b-E-47	2.4	4.6	-231	-982	517.0	11927	26161	PECIP	10945	0	10945

1.6 Conversion Factors

Conversion factors using English units as required by ECIP Guidelines dated April 25, 1988, are found in the Energy Analysis, Volume 4, Section 12. Supplemental conversion factors, for use in converting from English to SI units, are included in Table 1.6.1.

Table 1.6.1 - English to SI Conversion Factors

To convert from	To	multiply by
atmosphere (760 mm Hg)	pascal (Pa)	$1.013\ 25 \times 10^3$
board foot	cubic metre (m^3)	$2.359\ 737 \times 10^{-3}$
Btu (International Table)	joule (J)	$1.055\ 056 \times 10^3$
Btu (International Table)/h	watt (W)	$2.930\ 711 \times 10^{-1}$
Btu (International Table)·in./s·ft ² ·°F (k, thermal conductivity)	watt per metre kelvin [W/(m·K)]	$5.192\ 204 \times 10^2$
calorie (International Table)	joule (J)	$4.186\ 800^*$
centipoise	pascal second (Pa·s)	$1.000\ 000 \times 10^{-3}$
centistokes	square metre per second (m^2/s)	$1.000\ 000 \times 10^{-6}$
circular mil	square metre (m^2)	$5.067\ 075 \times 10^{-10}$
degree Fahrenheit	degree Celsius	$^{\circ}C = (^{\circ}F - 32)/1.8$
foot	metre (m)	$3.048\ 000 \times 10^{-1}$
ft ²	square metre (m^2)	$9.290\ 304 \times 10^{-2}$
ft ³	cubic metre (m^3)	$2.831\ 685 \times 10^{-2}$
ft·lbf	joule (J)	$1.355\ 818$
ft·lbf/min	watt (W)	$2.259\ 697 \times 10^{-2}$
ft/s ²	metre per second squared (m/s^2)	$3.048\ 000 \times 10^{-1}$
gallon (U.S. liquid)	cubic metre (m^3)	$3.785\ 412 \times 10^{-3}$
horsepower (electrc)	watt (W)	$7.460\ 000 \times 10^{+2}$
inch	metre (m)	$2.540\ 000 \times 10^{-2}$
in. ²	square meter (m^2)	$6.451\ 600 \times 10^{-4}$
in. ³	cubic metre (m^3)	$1.638\ 706 \times 10^{-5}$
inch of mercury (60°F)	pascal (Pa)	$3.376\ 85 \times 10^3$
inch of water (60°F)	pascal (Pa)	$2.488\ 4 \times 10^2$
kgf/cm ²	pascal (Pa)	$9.806\ 650 \times 10^4$
kip (1000 lbf)	newton (N)	$4.448\ 222 \times 10^3$
kip/in. ² (ksi)	pascal (Pa)	$6.894\ 757 \times 10^6$
ounce (U.S. fluid)	cubic metre (m^3)	$2.957\ 353 \times 10^{-5}$
ounce-force	newton (N)	$2.780\ 139 \times 10^{-1}$
ounce (avoirdupois)	kilogram (kg)	$2.834\ 952 \times 10^{-2}$
oz (avoirdupois)/ft ²	kilogram per square metre (kg/m^2)	$3.051\ 517 \times 10^{-1}$
oz (avoirdupois)/yd ²	kilogram per square metre (kg/m^2)	$3.390\ 575 \times 10^{-2}$
oz (avoirdupois)/gal (U.S. liquid)	kilogram per cubic metre (kg/m^3)	$7.489\ 152$
pint (U.S. liquid)	cubic metre (m^3)	$4.731\ 765 \times 10^{-4}$
pound-force (lbf)	newton (N)	$4.448\ 222$
pound (lb avoirdupois)	kilogram (kg)	$4.335\ 924 \times 10^{-1}$
lbf/in. ² (psi)	pascal (Pa)	$6.894\ 757 \times 10^3$
lbf/in. ³	kilogram per cubic metre (kg/m^3)	$2.767\ 990 \times 10^4$
lbf/ft ³	kilogram per cubic metre (kg/m^3)	$1.601\ 846 \times 10$
quart (U.S. liquid)	cubic metre (m^3)	$9.463\ 529 \times 10^{-4}$
ton (short, 2000 lb)	kilogram (kg)	$9.071\ 847 \times 10^2$
torr (mm Hg, 0°C)	pascal (Pa)	$1.333\ 22 \times 10^2$
W·h	joule (J)	$3.600\ 000 \times 10^3$
yard	metre (m)	$9.144\ 000 \times 10^{-1}$
yd ²	square metre (m^2)	$8.361\ 274 \times 10^{-1}$
yd ³	cubic metre (m^3)	$7.645\ 549 \times 10^{-1}$

- 1.1 PURPOSE OF THE STUDY
- 1.2 DATA GATHERING PHASE
- 1.3 INTERIM PHASE
- 1.4 FINAL PHASE
- 1.5 FACILITY DESCRIPTION

1.1 PURPOSE OF THE STUDY

The purpose of this study is to develop a systematic plan to reduce energy consumption and associated costs for the major buildings at Gruenstadt Depot, including Buildings 3555, 3556, 3559, 3571, and 3571A. This study is provided for the U. S. Army Corps of Engineers, European Division, to meet the requirements of the Energy Engineering Analysis Program (EEAP). The scope of work is included in Section 15 of the Energy Analysis Report. A brief description of the scope of work follows:

- o Perform a complete energy audit and analysis of the depot facility.
- o Identify and evaluate energy conservation opportunities.
- o Prepare programming and implementation documentation for economically feasible energy conservation opportunities.
- o List and prioritize recommended energy conservation opportunities.
- o Prepare a comprehensive report which will document the results and the recommendations.

Presently the depot has an energy conservation program, including energy conservation posters, and an energy awareness week each year. This report is prepared in the interest of continuing energy conservation efforts at the depot.

There are three major phases in reducing the energy consumption of the facility, including: Data Gathering Phase, Interim Phase, and the Final Phase. Following is a brief outline of the important steps in developing the energy conservation opportunities for Gruenstadt Depot.

1.2 DATA GATHERING PHASE

Data was gathered during field surveys. The field survey team consisted of three professional engineers and an industrial planner from Lockwood Greene Engineers, Inc., Dallas, Texas, USA, and two professional engineers from Phillip Holzmann Company, GERI Engineering, Frankfurt, Germany. Drawings obtained on site and at Worms were reviewed. Information was compiled and placed into separate volumes, titled "Data Gathering Report". The Data Gathering Report has been completed. All energy conservation opportunities (ECO's) listed in the scope were reviewed for technical feasibility. New ECO's were developed based upon engineering judgement and the data gathered. The field survey teams reviewed the data gathered on a continual basis to verify

that adequate information was collected for the existing building systems, mechanical systems, electrical systems, and processes. Gruenstadt depot personnel were interviewed to discuss the following:

- o Production Schedules
- o Equipment Operating Schedules
- o System Deficiencies
- o Energy Related Comments
- o Maintenance Procedures
- o Recent System Changes
- o Future Renovation Projects
- o Clarification of Systems where no Drawings were Available
- o Discussion and Review of Findings

1.3 INTERIM PHASE

ECO's were evaluated in detail in the Energy Analysis Report Data and included calculation of energy savings, maintenance cost increases or decreases, initial project cost, simple payback, and Savings Investment Ratio (SIR). ECO's which were determined to be financially feasible, were recommended for funding and were ranked in order of highest SIR to lowest SIR. A plan was also developed to prioritize the recommended ECO's for implementation.

1.4 FINAL PHASE

The Final Report has been completed. All economically feasible ECO's have been ranked and prioritized for implementation. The total interaction energy and operational savings for all recommended ECO's were calculated. Comments based upon the Interim Report were incorporated into the Final Report.

1.5 FACILITY DESCRIPTION

AAFES operates a production facility which produces baked goods, ice cream, and butchered meat products primarily for United States troops and dependents in Europe. This depot facility is located in Gruenstadt, Republic of West Germany, as indicated in the map of Figure 1.1.

The Gruenstadt Depot Facility consists of approximately 380,000 square feet of product and support buildings, as shown in the site plan of Figure 1.2 and as listed in Table 1.3. The facility

is under the jurisdiction of the U. S. Army Military Community Activity, Worms, which is part of the 21st Theatre Army Area Command.

The bakery, ice cream plant, meat processing plant, and cold storage areas are located in the two-story Building 3555. This is the largest building on site, with 240,000 square feet, and is where most of the energy saving opportunities exist. This building and many of the other buildings on site were originally built in the 1950's. Construction for this building and many of the other buildings on site typically consists of uninsulated concrete block walls, foam insulated roof and single pane glass. In 1982, the northwest portion of the two-story building 3555 was completely renovated to accomodate production of bread, rolls and sweet goods. Administrative areas were also remodeled.

Buildings on site are generally heated with steam. Ammonia refrigeration systems serve cold storage areas. Buildings are generally not air conditioned, with the exception of a few administrative areas. Within the last 5 years, some of the steam radiator heating systems have been converted to hot water radiator heating systems. Some insulation has been added to walls, single pane windows have been replaced with double pane windows. In 1986 a new boiler plant was built to provide steam for the site.

The general condition of the building construction varies from poor in some of the original cold storage areas to good in some of the recently remodeled administration and cold storage areas. The steam boiler plant is in excellent condition. The building steam heating systems installed in the 1950's in some areas are in poor condition. Hot water systems installed 1982 or later are in excellent condition. The buried site steam piping serving Building 3555 has been replaced since 1982. The buried steam piping serving Building 3559 was installed in the 1950's and should be replaced. More comprehensive descriptions of the condition of the building construction, mechanical systems, electrical systems and processes are found in Sections 2 and 5 of the Executive Summary report.

The production and administration areas of the facility operate primarily five days per week. The bakery and ice cream plant will sometimes operate on Saturdays.

Energy conservation activities are on-going at the depot facility, as evidenced by energy awareness posters in administration areas and year-to-date energy consumption graphs on the exterior wall of the boiler plant. Maintenance and boiler personnel manually shut off heating and ventilating equipment during unoccupied or non-production hours to reduce energy consumption.

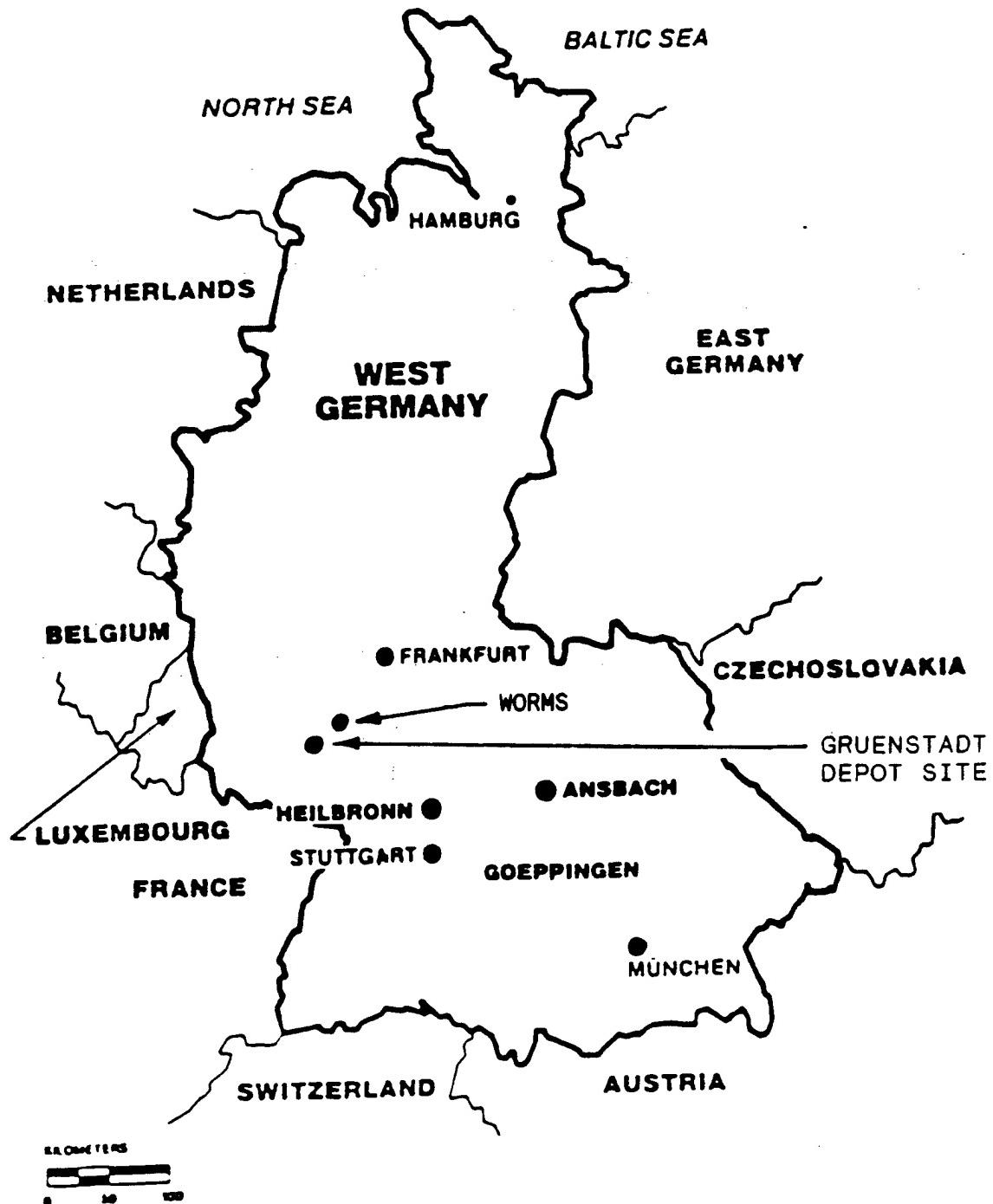
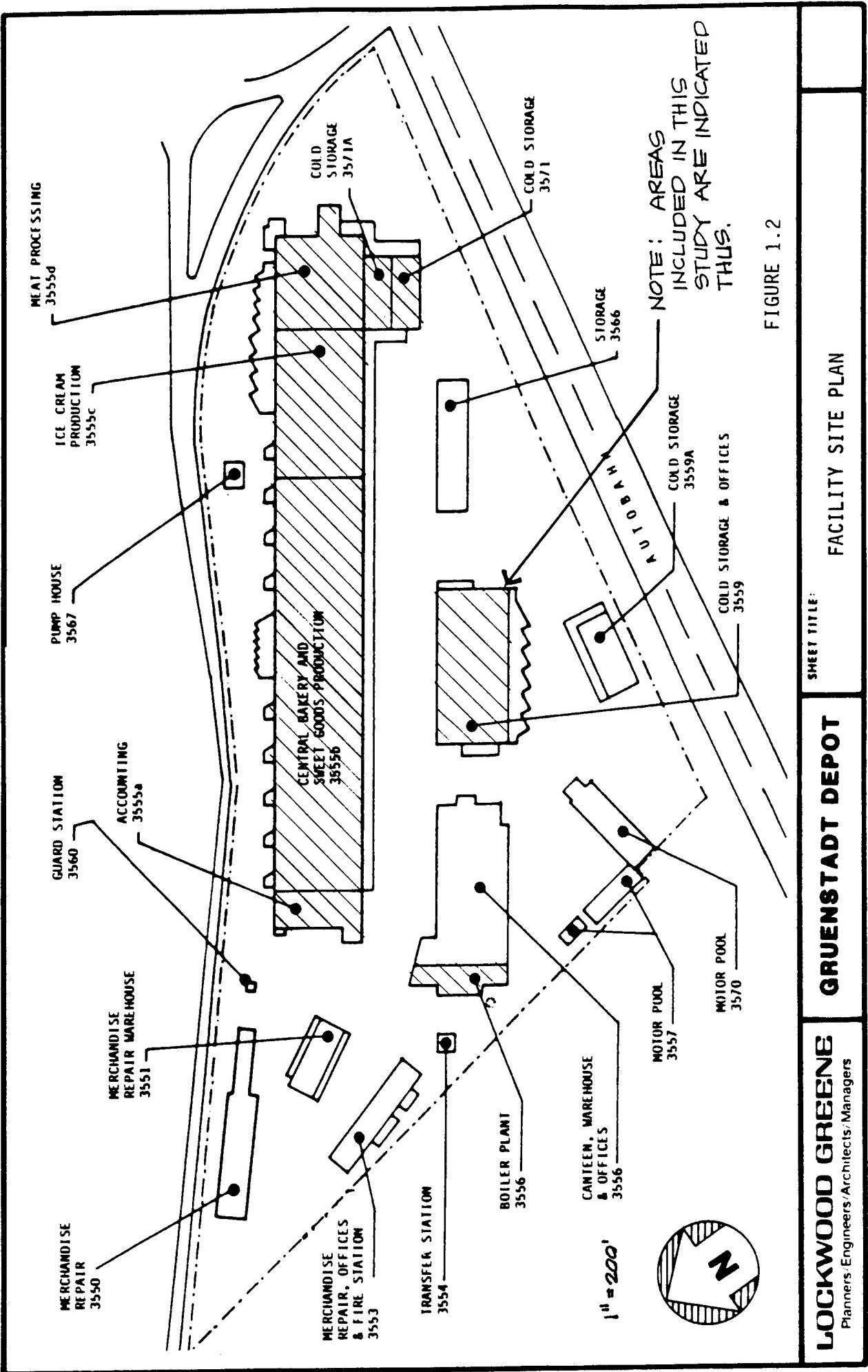


FIGURE 1.1 - PROJECT LOCATION



**Table 1.3
GRUENSTADT DEPOT FACILITY BUILDINGS**

<u>Bldg. No.</u>	<u>Building Description</u>	<u>Area (SF)</u>
3550	ODC. Merchandise Repair Plant	15,906
3551	Merchandise Repair Plant.	5,247
3552	Storage Warehouse	271
3553	Watch Reair Plant E&F Branch Fire Station	8,883
3554	Transformer Station	574
3555(*)	Accounting Branch. Bakery Ice Cream Production Meat Processing	241,237
3556	Canteen Bakery Warehouse Traffic Branch Training Room (*)Boiler Plant	40,101
3557	Motor Pool	3,211
3559(*)	Cold Storage Facility. Reforward Section Medical Detachment Quality Control Equipment Rental Plant Shoe Repair Plant	27,962
3559a.	Cold Storage Warehouse.	4,653
3560	Main Gate.	65
3566	Storage Warehouse	9,600
3567	Pump Station	506

3568	Service Station.	620
3569	Refuse Collection Building	98
3570	Motor Pool	9,853
3571(*)	Cold Storage	6,379
3571A(*)	Cold Storage Warehouse	3,537
3572	Operations General Purpose	74
	Total	378,837

(*) Buildings included in this study

Show total SF in study

$$\nabla \frac{SF_{(study)}}{SF_{(total)}}$$

- 2.1 SECTION OVERVIEW
- 2.2 BUILDING CONSTRUCTION
 - 2.2.1 GENERAL
 - 2.2.2 BUILDING 3555
 - 2.2.3 COLD STORAGE AREAS
 - 2.2.4 BUILDING 3559
- 2.3 MECHANICAL SYSTEMS
 - 2.3.1 GENERAL
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 - 2.3.3 CAPACITIES OF MECHANICAL SYSTEMS
 - 2.3.4 SITE UTILITIES
 - 2.3.5 CENTRAL BOILER PLANT
 - 2.3.6 CENTRAL REFRIGERATION SYSTEMS
 - 2.3.7 BUILDINGS 3555a AND 3555b
 - 2.3.8 BUILDING 3555c
 - 2.3.9 BUILDING 3555d
 - 2.3.10 BUILDING 3559
- 2.4 ELECTRICAL AND LIGHTING SYSTEMS
 - 2.4.1 GENERAL
 - 2.4.2 ELECTRICAL SERVICE
 - 2.4.3 SUBSTATIONS
 - 2.4.4 LIGHTING

The narrative of this section should be pared down for an Executive summary.

SECTION 2

ANALYSIS OF EXISTING BUILDING SYSTEMS

2.1 SECTION OVERVIEW

Existing building systems are presented in order to indicate areas of potential energy savings. The overall condition and energy related features of building construction, mechanical systems, and electrical systems are described for the facility.

2.2 BUILDING CONSTRUCTION

2.2.1 GENERAL:

Buildings 3555, 3559 and 3571 were built in approximately the same period, between 1953 and 1958, and utilized similar construction methods and materials. Building 3571A was built around 1962 in an area between Bldg 3555 and 3571. Present day functions for several of the buildings have changed from the original design function.

The following are descriptions of building construction features in each building, with a primary emphasis on energy consumption. These descriptions outline some of the differences between building envelope and internal processes.

2.2.2 BUILDING 3555:

This building includes administration areas (3555a), bakery production (3555b), ice cream production (3555c), and meat processing (3555d). Building 3555 is a large food processing facility covering roughly 241,237 SF. The breakdown of the building into functional areas is shown in Figure 2.2.1. This long rectangular shaped building can be identified using column designations. Note the column designations 1 to 27 from east to west and A to E from north to south. Four functional areas within the building are easily blocked between columns. Thus, the building is divided into four sub-buildings and named as follows:

<u>Designation</u>	<u>Columns</u>	<u>Functional Area</u>
Bldg 3555a	1A to 3E	Accounting
Bldg 3555b	3A to 18E	Bakery and Sweet Goods
Bldg 3555c	18A to 24E	Ice Cream Production
Bldg 3555d	24A to 27E	Meat Processing

Bldg 3555a is distinguished as the "high building" or the building with two full floors. A full basement runs from column 16A to 27E. Bldg 3555b consists mostly of one floor with high

ceilings. There is a small area with mezzanine between columns 11.5A and 12C. Bldg 3555c consists mostly of one floor with high ceilings. A small mezzanine area is found between columns 19.5A and 21A.5. Bldg 3555d also consists mostly of one floor with high ceilings. There is a mezzanine between columns 26.5A and 27E.

Exterior walls for all of Bldg 3555 were built with 12 inch hollowstone masonry blocks coated on both sides with cement plaster. The basic floor unit was 6 inches of reinforced concrete with about 2 inches of "hardtop" finish concrete.

Energy considerations required alteration of the original units of construction in various parts of Bldg 3555. For example, the entire roof was replaced such that the basic roofing unit now has higher insulating value. Low temperature cold storage rooms in Bldgs 3555c and 3555d required additional insulation in the floors, walls and ceilings.

Details of construction of walls, roofs, ceilings and floors in each of the Bldg 3555 sub-buildings are found in subsequent sections.

The primary functional area within Building 3555a is Accounting, with offices, break areas and data processing on the second floor. Spaces on the first floor include personnel entrance corridors and break areas, locker rooms, and machine shop. These spaces are specifically designed with human comfort in mind. Original construction was renovated to insulate the roof. Windows are double pane insulated.

Within Bldg 3555b, the primary function is for bakery food production. The roof is insulated while walls and floors are not. Windows are single pane glass. The resulting insulation values are consistent for a building with high internal heat gains. Insulation in the roof limits solar heat gains. The lack of wall and floor insulation allows heat losses from the space

Ice cream and frozen dairy goods production and cold storage is the primary function of Bldg 3555c. Much of the insulation from original construction remains in the spaces today. Some urethane panels have been installed in the building and these represent today's industry standard.

Meat processing and cold storage is the primary function of Bldg 3555d. Much of the cork insulation in the walls from the original installation has been replaced with styrofoam. Urethane ceiling panels cover much of the cold rooms.

Cork in the floor of the Meat Production Plant was removed and was not replaced with any other insulation. Interviews with maintenance personnel have revealed that the cork floor insulation has crumbled and deteriorated in many areas. The tiles on the floor of the meat processing area and concrete floors in some cold storage areas have deteriorated due to temperature differences between the cold spaces and the basement below.

2.2.3 COLD STORAGE AREAS

Cold storage areas in this subsection include Buildings 3555, 3571 and 3571A. The temperatures maintained within the cold storage spaces are indicated in Figure 2.2.2. Cold Storage Building 3559 is covered under subsection 2.2.4.

The cold storage areas of Bldg 3555c and 3555d form another functional area that overlaps the types of food produced in each. In addition, cold storage is the sole function of Bldgs 3571 and 3571A. This section covers cold storage areas of the three buildings to reduce repetition of discussions for each.

Thirty years of evolution in cold storage warehouse construction methods and materials are represented in the various cold storage areas of the four buildings. The oldest methods used cork and were followed by polyurethane foam and styrofoam as the primary insulation material. Each of the methods and materials have advantages and disadvantages worthy of note.

Cork insulation is very effective as an insulator. However, it is porous and requires careful installation and vapor sealing to minimize permeability. Once damaged, the vapor barrier may be difficult to restore. This allows moisture into the porous cork and effectively reduces the value of the insulation.

Prefabricated "Bally" panels consist of polyurethane foamed in place between two sheets of aluminum. They provide the same insulation value as cork with about half the thickness. When applied properly, they provide improved resistance to permeability. The prefabrication process constrains installation to envelopes of predetermined dimensions.

Foil backed styrofoam has insulation and permeability values somewhere between cork and polyurethane. It is more readily installed in various configurations of existing structures than prefabricated panels. It is an improvement over cork in both insulation and permeability ratings. It does require careful application, especially in maintaining the vapor seal on the warm side of the insulation.

A concerted effort has been made to replace cork insulation with foil backed styrofoam, when possible. Most cork insulation in the meat plant has been replaced with styrofoam. Most cork insulation in the ice cream hardening and cold storage warehouse remains in place.

Two prefabricated "Bally boxes" have been installed using the polyurethane sandwich panels. One was built for Novelty ice cream storage and is located within Bldg 3555c. The other was installed as a separate building.

Building 3571A is a self-standing "Bally box" structure located between the walls of Bldgs 3555d and 3571. It was built for the sole purpose of storing frozen goods. Unlike the sheltered Novelty Storage box, this structure is exposed to the outdoors. It was built circa 1982 with perhaps the most current methods and materials.

Building 3571 was built at about the same time as Bldg 3555 but for the sole purpose of storing frozen goods. The same types of masonry units were used in each building, but Bldg 3571 had additional layers of insulation. Much of the original insulation in this structure has been replaced with foil-backed styrofoam.

The type and age of each insulation installation must be considered in estimating the present day insulation value. The older cork installations are most likely to be deteriorated. Patches to floors and walls are typically visible and suggest the likelihood of moisture in the cork. Styrofoam insulation is less likely to have deteriorated yet equally sensitive to proper vapor barrier installation. Polyurethane panels are perhaps least likely to be deteriorated given average installation techniques and wear and tear.

2.2.4 BUILDING 3559

Building 3559 is mostly a chilled and cold storage warehousing facility with some offices, a shoe repair shop, an equipment rental service and other storage areas. It was built about the same time as Bldg 3555 and with similar floor and wall materials. Figure 2.2.3 indicates space temperatures of the cold storage areas.

The roof utilizes a truss design with a low insulation value in both the roof and ceiling. Insulation in the chilled and cold storage area walls is cork from the original installation. Floors and ceilings are typically not insulated.

Windows are typically single pane, untinted glass. A variety of door types includes glass, insulated, steel and plastic strip. High pedestrian traffic results in entry doors that are left open, perhaps more so than in Bldg 3555.

2.3 MECHANICAL SYSTEMS

2.3.1 GENERAL

All major buildings on site are served by the central boiler plant in Building 3556. The steam is used for space heating, domestic water heating, and process steam.

The cold storage areas of Buildings 3555, 3571 and 3571A are served from the central ammonia refrigeration equipment in the basement of Building 3555. Some packaged direct expansion freon fan coil and window units provide cooling requirements for some of the administration areas. Cold storage areas of Building 3559 are cooled with packaged freon direct expansion refrigeration units.

The operating parameters for the heating, ventilating, and refrigeration distribution equipment are indicated in Table 2.3-1. The table includes unit description, area served, motor HP, operating kW, and operating schedule for all major mechanical systems. This data was used for DOE-2.1c input for the baserun and for ECO calculations. Much of the motor kW data was field measured during the data gathering efforts. The locations of major pieces of mechanical equipment are shown in Figure 2.3.1.

2.3.2 MAINTENANCE PROCEDURES

Operating personnel place a special emphasis upon energy conservation. Heating systems are manually turned on upon demand when the heating season starts, on a daily basis. Ventilating systems are manually shut down during non-production periods. Heating water temperatures are adjusted to the lowest possible temperatures to offset building heat losses. A large poster outside the boiler plant indicates annual gas usage, with a target usage.

The maintenance of the mechanical systems for the facility is performed through a combination of on-site personnel and maintenance contracts. All mechanical systems have been maintained well, as evidenced by the fact that the original systems installed between 1953 and 1958 in Buildings 3555 and 3559 are still fully operational.

2.3.3 CAPACITIES OF MECHANICAL SYSTEMS

The mechanical central plant heating systems appear to have ample heating capacity. The peak steam demand load, per utility bills, is 15,900 lbs/hr in December 1987. Since each boiler will produce 13,200 lbs/hr of steam, two boilers will easily handle the peak steam load, with a third boiler for standby use.

The central refrigeration systems appear to operate at peak capacity during the hottest summer periods, per discussions with operating personnel. Due to increased production of ice cream, and increased infiltration loads in the cold storage areas, the refrigeration equipment is fully taxed. The main central system operates with all ten high stage compressors and all six low stage compressors on a continual basis. Over the weekend, the cold storage areas are cooled to their lowest temperatures (i.e., -45°F in the Hardening Room). Then, during the week the temperatures creep upward until they reach their peak Friday afternoon (i.e. -30°F in the Hardening Room). Although the refrigeration systems appear to meet the needs of the present cold storage areas, they do not have enough capacity to handle peak loads on a daily basis.

The older building heating systems including steam radiators, serving Buildings 3555c and 3559, are in poor condition and have poor space temperature controls. Although the systems appear to have adequate heating capacity, the steam is very hard to control with manual radiator valves. As a result, spaces are overheated. Windows are opened to compensate for the increased heat. Often the radiators are turned off and floor mounted, thermostatically controlled, electric heaters are used for space heating, further increasing energy costs. Although the systems have adequate capacity, the poor temperature control results in inadequate heating systems.

The newer building heating systems consist of heating water radiators and heating water temperature reset controls. These systems were installed in Buildings 3555a, 3555b and 3555d in 1982 and 1986 during major remodeling projects. The systems appear to have adequate heating capacity. However, per discussions with user personnel, sometimes the heating water temperature is adjusted too low in the mechanical room to provide adequate capacity for space heating. Adjustments are needed to optimize the heating water temperatures against space heat losses, to maintain satisfactory space temperatures without supplemental floor mounted electric heaters.

2.3.4 SITE UTILITIES

Natural gas is metered at two points within the depot, as indicated in Figure 2.3-2. One meter measures demand and consumption at the central plant where boilers produce steam for distribution in the facility. The other meter measures demand and consumption for the bakery and sweet goods ovens, proofers, and fryers.

Water is metered for two end uses. Make-up water is used for cooling of refrigeration compressors, the ice cream pasteurizing heat exchanger, and evaporative coolers. Water is also used for production, cleaning, and domestic uses. Figure 2.3-3 indicates the locations of five water meters serving the facility.

Separate storm and sanitary sewer lines exit the site to the north. Several sanitary pump stations are located on site.

Steam and condensate return piping runs from the central boiler plant in Building 3556 to Buildings 3550, 3553, 3555, 3557, and 3559. Steam and condensate piping was originally installed in 1958. New piping was installed in 1982 to serve 3555. Figure 2.3-4 shows the routing of the steam and condensate lines on site.

2.3.5 CENTRAL BOILER PLANT

The entire central boiler plant was installed new in 1986 to serve the facility with high pressure steam, medium pressure steam, and low pressure steam. The central boiler plant includes three nominal 400 HP firetube 3 pass steam boilers producing 120 psig steam, with stack economizers, vapor heat recovery, combustion air preheat, deaerator boiler feed, automatic flue gas sensing for oxygen and carbon monoxide, and feedwater chemical treatment. The boiler system incorporates many accessories to maximize energy efficiency, and is in excellent condition.

Modifications can be made to the central plant boiler system to increase energy efficiency as follows:

- o Adjustments to the existing boiler controls should be made on a periodic basis to maximize energy efficiency. The attached strip chart recorder, Figure 2.3-5, indicates different values of oxygen in the flue gas for two operating boilers. Boiler efficiency can increase 2% by reducing flue gas oxygen content from 9% to 5%.
- o Figure 2.3-6 indicates large swings in tons/hr within short periods of time. Gas demand charges can be reduced by providing smoother operating controls for the steam.
- o Additional boiler system controls are needed to measure and monitor the steam demand and usage for each building in order to identify large loads as a target for energy conservation.

2.3.6 CENTRAL REFRIGERATION SYSTEMS

There are three ammonia refrigeration systems serving the cold storage rooms in Buildings 3555, 3571 and 3571A. Two of these

systems, labeled CR-1 and CR-2, have been interconnected and they serve the cold storage areas in Building 3555. System CR-3 serves the Bally Novelty storage freezer.

System CR-1 is a two-stage refrigeration system having a condensing temperature of 96°F, an intercooler or intermediate stage at 5°F, and a low stage at -40°F. The high stage has a total installed capacity of 620 TR consisting of ten (10) vertical reciprocating compressors, seven (7) evaporative condensers having a total capacity of 822 TR, dedicated evaporative cooler water circulating pumps, a high pressure receiver, and an oil separator. The intermediate stage at 5°F consists of one intercooler which serves as a transfer step between the high and low stages. The -40°F low stage consists of six (6) rotary vane compressors having a capacity of 582 TR, a low stage separator and liquid ammonia pumping system.

The high stage serves the following spaces and equipment:

Meat Tempering Rooms	28°F
Butter Storage Room	32°F
Borsig Chiller	40°F
Ice Cream Plant	50°F

The low stage serves the following:

Meat Storage Room	-20°F
Main Storage Room	-30°F
Ice Cream Hardening Room	-30°F
Ice Cream Production Equipment	-20°F
Pre-Fab Storage Building	-20°F
Frozen Product Storage	-20°F

System CR-2 is cross-connected to the CR-1 system. This system is similar to CR-1 and the low stage serves the -20° brine chiller. The high stage has a 50 TR vertical reciprocating compressor, a 48 TR evaporative condenser and a high pressure receiver. The intermediate stage has one intercooler. Originally this system had a low stage rotary vane compressor which was removed when systems CR-2 and CR-1 were cross-connected.

System CR-3 is similar to CR-1. The design pressures and temperatures for each of the stages are the same as CR-1. The high stage has two (2) vertical reciprocating compressors having a total capacity of 48 TR, an evaporative condenser having a capacity of 67 TR, and a high pressure receiver. The intermediate stage has an intercooler and the low stage has two (2) rotary vane compressors with a total installed capacity of 40 TR. This system serves the Bally Novelty Storage Freezer at -20°F.

Each refrigeration system is served with evaporative condensers. Three of the existing evaporative condensers are Frick condensers which are over 25 years old. Based on the design capacities for the evaporative condensers (840 TR) there is adequate capacity, (820 TR required). However, because of the age of the three (3) condensers they are probably not operating at design capacity. Operating personnel at the facility indicate this to be the case. These units should be replaced with new evaporative condensers of adequate capacity.

2.3.7 BUILDING 3555a AND 3555b

The accounting and bakery portions, Buildings 3555a and 3555b, have hot water heating systems, served from the same heating water distribution system. The mechanical room is served with nominal 120 psig steam. The space heating system and domestic water heating system heat exchangers have pumped condensate return systems.

Some modifications are needed for the domestic hot water and space heating systems, including:

- o Condensate return system for the steam main drip traps and production equipment.
- o Replacement of leaking steam traps.
- o Domestic water preheat system using air compressors and/or oven stack heat.

The ventilation system for 3555a administration consists of toilet exhaust fans, a ventilating unit AH-1, and two split system direct expansion vertical fan coil cooling units. Outdoor air enters the building through AH-1, the adjacent bakery 3555b, outside doors, and windows.

The ventilation system for 3555b bakery consists of four outdoor air handling units, AH-2 through AH-5. The units have outdoor air, return air, and relief air control dampers. Three of the units have supply and return fans. Space heating is accomplished through duct mounted hot water heating coils.

A summer/winter switch controls the mode of all of the bakery ventilating units. When in summer mode, the outdoor air damper is fully open, and fans run on high speed. When in winter mode, the outdoor air damper is open 20% and fans run on low speed. Since one summer/winter switch controls all four fan systems, energy is wasted from spaces overheating and overcooling. The air handling systems are in excellent condition. However, modifications are needed to reduce energy consumption of the heating and ventilation systems, including the following:

- o Automatic economizer cycle controls.
- o Independent temperature controls for each air handling unit.
- o Additional exhaust fans over ovens to reduce heat build-up.
- o Transfer fans to move heated air from ovens to colder areas.
- o Ceiling fans to reduce stratification and resulting heat losses during winter heating season.
- o Automatic controls to turn on heating systems upon demand, when outdoor air temperature is low enough, rather than relying upon manual operation.
- o Automatic time switch control for roof exhaust fans to reduce heating and electrical energy requirements.
- o Time switch control of toilet exhaust fans.
- o Unit heaters for unoccupied period heating, to reduce fan kWh, and to reduce outdoor air heating requirements.

Process cooling systems serve bread and roll mixers and the liquid sponge ice maker. The systems are in excellent operating condition. However, energy savings can be realized from the following modifications:

- o Domestic water preheat heat exchanger in the refrigerant piping.
- o Liquid pressure amplifier refrigerant pumps to increase refrigeration system energy efficiency.

- o Electrical demand reduction through ice storage and operation of the ice maker at night only.

2.3.8 BUILDING 3555c

The original mechanical system serving the ice cream production area 3555c was installed in 1955, including the steam pressure reducing station, steam distribution piping between the main header and steam equipment, domestic water tanks, and most of the piping and insulation. New heating ventilating units with steam coils were installed in 1965 when the ice cream plant was constructed. The condition of the newer heating/ventilating units is good, while the condition of the older steam piping, PRV station, insulation, steam traps, and domestic hot water tanks is poor. Modifications can be made to the existing system to reduce energy consumption, including:

- o Condensate return system.
- o Conversion of steam mixer hoses from steam to hot water, to reduce boiler steam demand changes.
- o Conversion of heating system from steam to hot water to improve space temperature control, reduce space overheating, reduce energy waste, and eliminate use of floor mounted electric heaters.
- o Insulation of basement domestic hot water tanks.

Ventilation systems consist of heating/ventilating units with steam coils and no cooling. The ice cream production area is normally negative and should be slightly positive. Modifications can be made to the ice cream production to reduce consumption of utilities.

- o Domestic water is used to cool ice cream mix in the high temperature short time pasteurizing heat exchanger, and is then wasted down the floor drain. An evaporative cooler can reduce the waste.
- o Clean-in-place equipment sends hot wash water down the drain during the final rinse cycle. This hot rinse water could be saved for the initial rinse cycle, thereby reducing heating requirements.

323.9 BUILDING 3555d

The original mechanical system was installed in 1955. New heating systems were installed in 1986, including insulated steam

piping, insulated domestic water tanks, condensate return pump, heating water heat exchanger, heating water pumps, and controls. The newer systems are in excellent condition.

The meat processing room is served by cooling unit AH-16, which includes direct expansion freon cooling coil, condenser coil, supply and return fans, and fixed outdoor air control damper. This system was installed in 1958, and is in good condition. The system can be improved to reduce energy consumption via the following:

- o Moving the condenser coil outdoors where lower ambient temperatures reduce compressor kW.
- o Liquid pressure amplifier pump in the refrigerant piping increases cooling system efficiency.
- o Low leakage modulating control dampers in the outdoor air duct automatically close during the non-production hours.
- o Air handling unit cycles off during the non-production hours to reduce fan electrical kWh usage.

2.3.10 BUILDING 3559

The original mechanical systems were installed in 1953, and include steam radiator heating of office areas and packaged freon direct expansion refrigeration equipment serving the cold storage areas. Domestic hot water use is minimal and is heated electrically. The mechanical systems are in poor condition and should be replaced. Changes to the mechanical systems which can improve energy efficiency include:

- o Converting the heating system from steam to hot water to provide better space temperature control, to eliminate the use of floor mounted electric heaters, and to reduce heating system energy losses.
- o Replacement of the old and deteriorated buried steam and condensate mains between the central boiler plant and the building.
- o Replacement of some of the freon refrigeration equipment serving cold storage areas with higher efficiency equipment.

2.4 ELECTRICAL AND LIGHTING SYSTEMS

2.4.1 GENERAL

The electrical distribution and lighting systems at Gruenstadt have been well maintained. Recently accomplished improvement

projects, and those pending or in progress, assure continuity of reliable and adequate power distribution to utilization equipment. Lighting projects and enhancements in place are returning the respective investments; e.g., use of energy-efficient fluorescent lamps and low-pressure sodium lighting outdoors.

2.4.2 ELECTRICAL SERVICE

The electrical distribution system at Gruenstadt is supplied via one underground radial circuit owned by the municipality Stadtwerke Gruenstadt. This circuit is 20 kV, 3-phase, 50 Hz. The service entrance point is now substation IV. From there it loops to each of I, II and III. An emergency 20 kV feed, not normally used, also connects to Substation I; however, it is inadequate for the facility demand. The electric utility meters kW Hr energy consumption and kW power demand at Substation IV.

Substation I also feeds the ancillary buildings, at 400/231 VAC, 3-phase, 50 Hz.

2.4.3 SUBSTATIONS:

Refer to Figure 2.4-1 for locations of substations on the site. Substation I occupies Building 3554. Presently it utilizes two 500 kVA transformers. Under Project WL-00740-7P these are to be replaced by two 630 kVA units and the low-voltage switchgear replaced.

Substation I serves the following loads:

Building 3556	Heating Room
3556	Laundry
3553	Maintenance, Fire Department
3557	Motor Pool
3570	Motor Pool
3551	Headquarters Repair
3559	Cold Storage
3555	Accounting
	Exterior Lighting

Substation II is located in the east-end basement of Building 3555. In 1987, the four old 400 kVA transformers were changed out to 630 kVA units.

Substation II serves all loads east of the ice cream plant in Building 3555 on the ground floor. In the basement space, it supplies all refrigeration except the Bally Box, including the workshop and about 25 kW of load associated with the ice cream plant.

Substation III has two 400 kVA transformers of 1968 vintage; also, a new 630 kVA unit and switchboards have been installed under Project #WL-00970-SP.

In the future, plans call for changing out the two 400 kVA units to 630 kVA, also. At the time of the field survey, the 630 kVA unit was not carrying any load.

Substation III serves the light bakery, ice cream plant, including refrigeration, sweet goods, baby box, pizza, and lighting in the bakery.

Substation IV consists of two 800 kVA transformers installed in 1981.

Substation IV feeds the bakery (except #3555a accounting and lighting), 1st floor of #3555a, and all bakery production and HVAC, except that served by III.

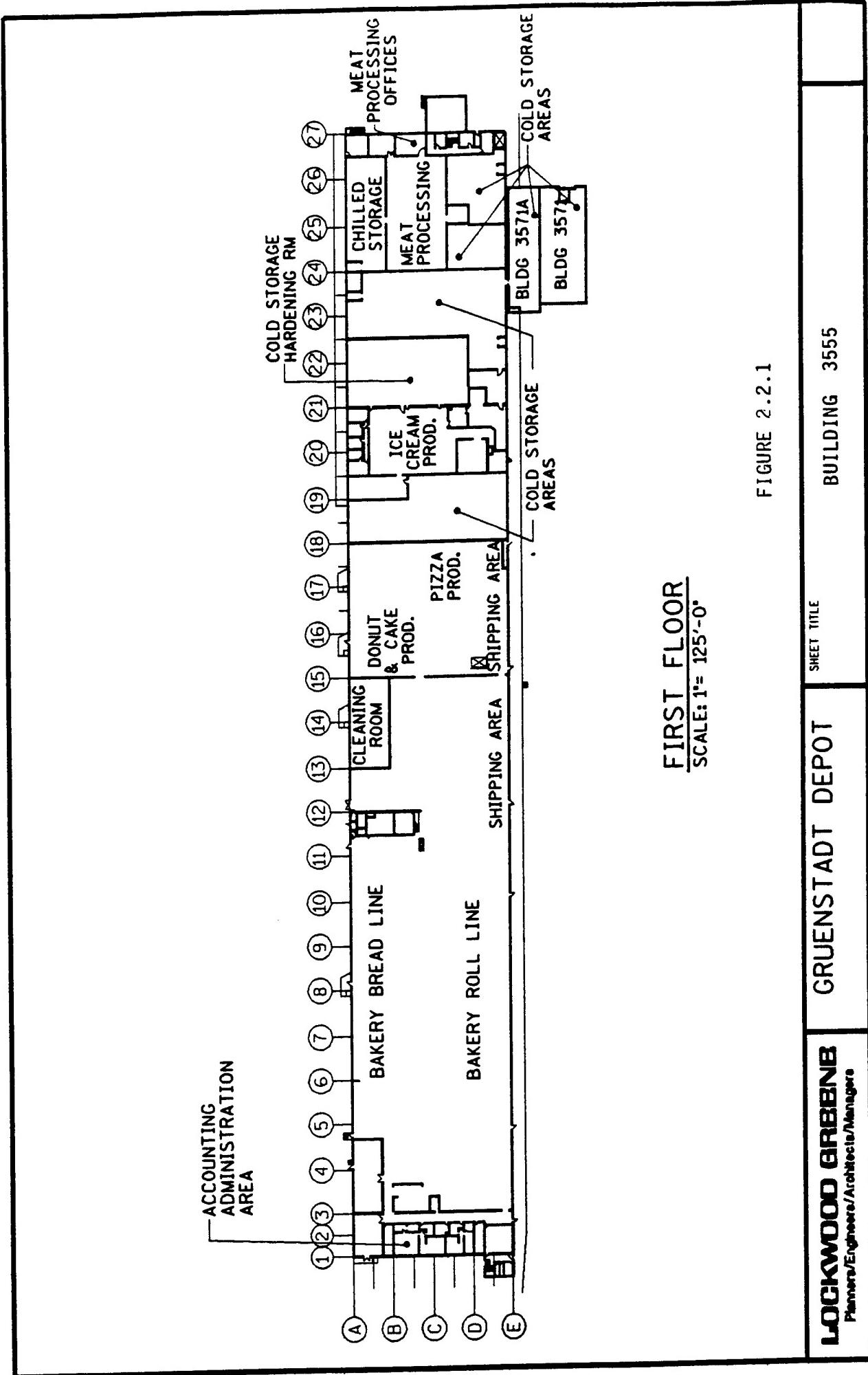
2.4.4 LIGHTING

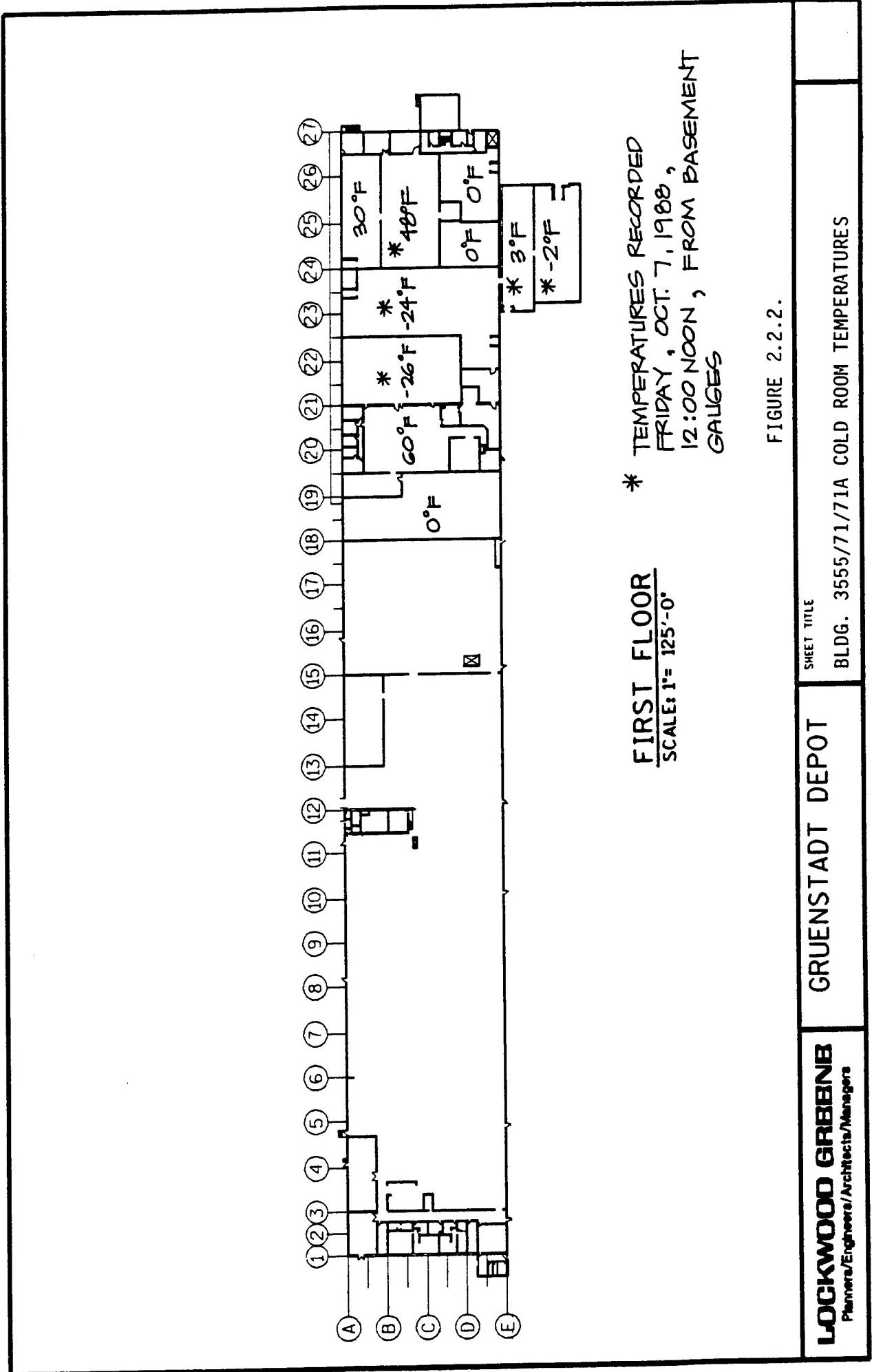
Perimeter site lighting utilizes pole-mounted low-pressure sodium fixtures which are very energy efficient.

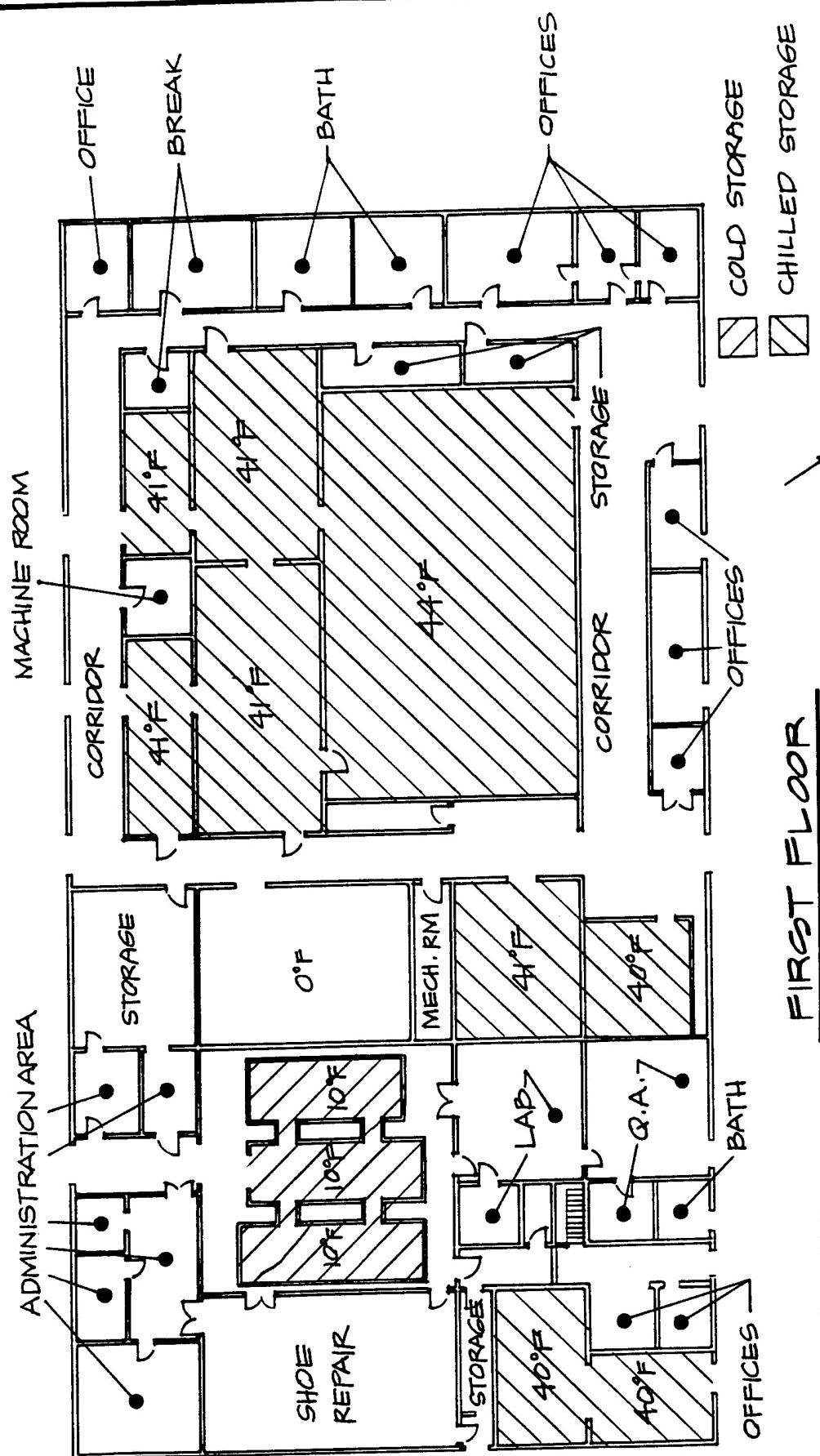
Outside building lighting utilizes primarily fluorescent; however, a few quartz and high-pressure mercury lamps are used also.

Interior lighting in Building 3555 uses fluorescent exclusively. These fixtures are well-suited for the relatively low ceiling heights and the need for efficient, diffused lighting having good color rendition.

Refer to Data Gathering Volume II of III, Sections 8.3.1 and 8.3.2 for quantifications and detailed descriptions of perimeter and outside lighting systems. Generally, systems are suitable and in good condition. A combination of automatic and manual controls is utilized.







N FIGURE 2.2.3.

FIRST FLOOR

SCALE: 1" = 30'-0"

GRUENSTADT DEPOT		SHEET TITLE
LOCKWOOD GREENE	Planners/Engineers/Architects/Managers	BLDG. 3559 GROUND FLOOR PLAN

TABLE 2.3-1 MECHANICAL EQUIPMENT OPERATING CRITERIA

UNIT DESCRIPTION	BLDG.	SERVES	MOTOR HP	OPERATING KW	OPERATING SCHEDULE
AH-1: PACKAGED UNIT LOCATED IN MACHINE SHOP, 100% OUTDOOR AIR	3555a	NORTHEAST CORNER OF BLDG. 3555 AND MACHINE SHOP AREA DOE ZONE/AHU: Z1, Z8, Z9, Z10/H&V1	3	1.7	UNIT IS GENERALLY OFF, ONLY OPERATES DURING COLDEST WEATHER, RUNS CONTINUALLY
AH-2: BUILT-UP UNIT LOCATED OUT-DOORS, SUPPLY & RETURN AIR FANS, DUCT MOUNTED HW COIL, SUMMER/WINTER MODE	3555b	BAKERY LIQUID SPONGE & MIXING DOE ZONE/AHU 2.3/H&V2	40 SUPPLY 30 RETURN	24.2 SUPPLY 20.6 RETURN	OPERATE CONTINUALLY DURING WEEK, OFF 2PM SATURDAY - 9PM SUNDAY, FIELD MEASURED AMPS
AH-3: BUILT-UP UNIT LOCATED OUT-DOORS, SUPPLY & RETURN AIR FANS, DUCT MOUNTED HW COIL, SUMMER/WINTER MODE	3555b	BAKERY OVENS & PROOFERS, PACKAGING DOE ZONE/AHU: Z3A/H&V3	40 SUPPLY 30 RETURN	14.7 SUPPLY 12.6 RETURN	OPERATE CONTINUALLY DURING WEEK, OFF 2PM SATURDAY - 9PM SUNDAY, FIELD MEASURED AMPS
AH-4: BUILT-UP UNIT LOCATED OUT-DOORS, SUPPLY & RETURN AIR FANS, NO HEATING, SUMMER/WINTER MODE	3555b	BAKERY SHIPPING DOE ZONE/AHU: Z4, Z5, Z6, Z11/H&V4	40 SUPPLY 30 RETURN	24.8 SUPPLY 21.1 RETURN	OPERATE CONTINUALLY DURING WEEK, OFF 2PM SATURDAY - 9PM SUNDAY FIELD MEASURED AMPS
AH-5: BUILT-UP UNIT LOCATED OUT-DOORS, SUPPLY FAN ONLY, SUMMER/WINTER SWITCH	3555b	SWEET GOODS PRODUCTION DOE ZONE/AHU: Z7/H&V5	30 SUPPLY	16.4 SUPPLY	OPERATE CONTINUALLY DURING WEEK, OFF 2PM SATURDAY - 9PM SUNDAY FIELD MEASURED AMPS
AH-6, 7: TWO PACKAGED UNITS WITH AMMONIA COILS	3555c	NOVELTY COLD STORAGE, BALLY BOX DOE ZONE/AHU: Z12/AH-Z12	2 @15 EA.	17.4	RUNS CONTINUALLY
AH-8: PACKAGED AIR HANDLING UNITS	3555c	ICE CREAM PRODUCTION DOE ZONE/AHU: Z13, Z14, Z30/AH-Z30	--	8	RUNS CONTINUALLY
AH-9, 10, 11, 12: BUILT-UP UNITS IN BASEMENT, AMMONIA REFRIGERATION	3555c	ICE CREAM HARDENING ROOM DOE ZONE/AHU: Z17/AH-Z17 COILS	4 @15 EA.	34.8	RUNS CONTINUALLY
AH-13, 14: BUILT-UP UNITS IN BASEMENT, AMMONIA REFRIGERATION COILS	3555c	MAIN COLD STORAGE ROOM DOE ZONE/AHU: Z18/AH-Z18	2 @15 EA.	17.4	RUNS CONTINUALLY

UNIT DESCRIPTION	BLDG.	SERVES	MOTOR HP	OPERATING KW	OPERATING SCHEDULE
AH-15: PACKAGED UNIT LOCATED IN SPACE, AMMONIA REFRIGERATION COILS	3555d	RAW MEAT TEMPERING ROOM DOE ZONE/AHU: Z21/AH-Z21	5	2.9	RUNS CONTINUALLY
AH-16: PACKAGED SPLIT SYSTEM UNIT LOCATED IN BASEMENT, R-12 REFRIGERATION COIL, SUPPLY & RETURN AIR FANS	3555d	MEAT PROCESSING ROOM	--	3.6 SUPPLY 2.7 RETURN 19.5 COMP. 1.7 COND.	WEEKDAYS ON 5AM TO 4PM, WEEKENDS OFF
AH-17: PACKAGED UNIT LOCATED IN SPACE, AMMONIA REFRIGERATION COIL	3555d	MEAT STORAGE ROOM DOE ZONE/AHU: Z25/AH-Z25	5	2.9	RUNS CONTINUOUSLY 365 DAYS/YEAR
AH-18: PACKAGED UNIT LOCATED IN SPACE, AMMONIA REFRIGERATION COIL	3555d	COLD STORAGE DOE ZONE/AHU: Z23/AH-Z23	5	2.9	RUNS CONTINUOUSLY 365 DAYS/YEAR
AH-19: BUILT-UP UNIT IN BASEMENT, AMMONIA REFRIGERATION COIL	3571a	DOE ZONE/AHU: 3571A/AH-3571A	15	8.7	RUNS CONTINUOUSLY 365 DAYS/YEAR
AH-20: BUILT-UP UNIT LOCATED OUTSIDE, AMMONIA REFRIGERATION COIL	3571	DOE ZONE/AHU: 3571/AH-3571	16	9.3	RUNS CONTINUOUSLY 365 DAYS/YEAR
HVP-1: IN-LINE PUMPS FOR HW HEATING	3555b	HEATING FOR BAKERY & SWEET GOODS PRODUCTION AREAS & ADMINISTRATION	--	6	RUNS 24 HRS/DAY DURING HEATING SEASON, OCTOBER THROUGH MAY
RC-1: RECIPROCATING COMPRESSOR	3555b	PROCESS MIXER #1, BAKERY BREAD PRODUCTION	50	29	DURING WEEKDAY, WHEN OAT= 77° F, UNIT CYCLES ON 81% PER FIELD MEASUREMENT. UNIT IS ON WEEKDAY 3AM TO 9PM, ON SATURDAY 3AM TO 2PM. FIELD MEASURED AMPS
RC-2: RECIPROCATING COMPRESSOR	3555b	PROCESS MIXER #2, BAKERY BREAD PRODUCTION	50	29	DURING WEEKDAY, WHEN OAT= 77° F, UNIT CYCLES ON 86% PER FIELD MEASUREMENT. UNIT IS ON WEEKDAY 3AM TO 9PM, ON SATURDAY 3AM TO 2PM. FIELD MEASURED AMPS
RC-3: RECIPROCATING COMPRESSOR	3555b	PROCESS MIXER #3 BAKERY ROLLS PRODUCTION	50	29	DURING WEEKDAY, WHEN OAT= 77° F, UNIT CYCLES ON 5.3% PER FIELD MEASUREMENT. UNIT IS ON WEEKDAY 3AM TO 9PM, ON SATURDAY 3AM TO 2PM. FIELD MEASURED AMPS

UNIT DESCRIPTION	BLDG.	SERVES	MOTOR HP	OPERATING KW	OPERATING SCHEDULE
ACCU-1: RECIPROCATING COMPRESSOR & AIR COOLED CONDENSER COIL	3555b	LIQUID SPONGE ICE MACHINE	50	31.3	OPERATE CONTINUALLY 24 HRS/DAY DURING SUMMER PEAK, OFF 2PM SATURDAY, ON 3AM MONDAY, FIELD MEASURED AMPS
ACCU-2: RECIPROCATING COMPRESSOR & AIR COOLED CONDENSER COIL	3555b	LIQUID SPONGE ICE MACHINE	50	31.3	OPERATE CONTINUALLY 24 HRS/DAY DURING SUMMER PEAK, OFF 2PM SATURDAY, ON 3AM MONDAY, FIELD MEASURED AMPS
CU-1: AIR COOLED CONDENSER-DX	3555b	RC-1	4 FANS @1	2.3	UNIT IS INTERLOCKED WITH RC-1.
CU-2: AIR COOLED CONDENSER-DX	3555b	RC-2	4 FANS @1	2.3	UNIT IS INTERLOCKED WITH RC-2.
CU-3: AIR COOLED CONDENSER-DX	3555b	RC-3	3 FANS @1	1.7	UNIT IS INTERLOCKED WITH RC-3.
HC-1: RECIPROCATING HIGH STAGE COMPRESSOR	3555c	MAIN REFRIGERATION PLANT	100	51	OPERATE CONTINUALLY 24 HRS/DAY UPON DEMAND TO MAINTAIN COLD STORAGE ROOM TEMPERATURES. COMPRESSORS ARE MANUALLY TURNED ON & OFF. FIELD MEASUREMENTS INDICATED THAT COMPRESSORS HC-1 THROUGH HC-10 OPERATED WITH AN AVERAGE OF 51 KW
HC-2: RECIPROCATING HIGH STAGE COMPRESSOR	3555c	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-3: RECIPROCATING HIGH STAGE COMPRESSOR	3555c	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-4: RECIPROCATING HIGH STAGE COMPRESSOR	3555c	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-5: RECIPROCATING HIGH STAGE COMPRESSOR	3555c	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-6: RECIPROCATING HIGH STAGE COMPRESSOR	3555c	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-7: RECIPROCATING HIGH STAGE COMPRESSOR	3555c	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1

UNIT DESCRIPTION	BLDG.	SERVES	MOTOR HP	OPERATING KW	OPERATING SCHEDULE
HC-8: RECIPROCATING HIGH STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-9: RECIPROCATING HIGH STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-10: RECIPROCATING HIGH STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
HC-11: RECIPROCATING HIGH STAGE COMPRESSOR	3555C	NOVELTY STORAGE, BALLY BOX	40	36.1	OPERATES CONTINUALLY 24 HRS/DAY UPON DEMAND TO MAINTAIN COLD STORAGE ROOM TEMPERATURES. FIELD MEASURED AMPS
HC-12: RECIPROCATING HIGH STAGE COMPRESSOR	3555C	NOVELTY STORAGE, BALLY BOX	40	30.8	OPERATES CONTINUALLY 24 HRS/DAY UPON DEMAND TO MAINTAIN COLD STORAGE ROOM TEMPERATURES. FIELD MEASURED AMPS
HC-13: RECIPROCATING HIGH STAGE COMPRESSOR	3555C	ICE CREAM BRINE SYSTEM	75	--	COMPRESSOR NOT USED. BRINE SYSTEM IS INTER-CONNECTED TO MAIN REFRIGERATION PLANT COMPRESSORS.
LC-1: ROTARY VANE LOW STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	200	116	SAME AS HC-1. UNIT IS NORMALLY OFF, SINCE IT IS MUCH NOISIER TO OPERATE. UNIT PROVIDES STANDBY SERVICE.
LC-2: ROTARY VANE LOW STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
LC-3: ROTARY VANE LOW STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
LC-4: ROTARY VANE LOW STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
LC-5: ROTARY VANE LOW STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1

UNIT DESCRIPTION	BLDG.	SERVES	MOTOR HP	OPERATING KW	OPERATING SCHEDULE
LC-6: ROTARY VANE LOW STAGE COMPRESSOR	3555C	MAIN REFRIGERATION PLANT	100	51	SAME AS HC-1
LC-7: ROTARY VANE LOW STAGE COMPRESSOR	3555C	NOVELTY STORAGE, BALLY BOX	40	36.1	OPERATES CONTINUALLY 24 HRS/DAY UPON DEMAND. FIELD MEASURED AMPS
LC-8: ROTARY VANE LOW STAGE COMPRESSOR	3555C	NOVELTY STORAGE, BALLY BOX	40	37.9	OPERATES CONTINUALLY 24 HRS/DAY UPON DEMAND. FIELD MEASURED AMPS
LC-9: ROTARY VANE LOW STAGE COMPRESSOR	3555C	ICE CREAM BRINE SYSTEM	50	--	COMPRESSOR NOT USED, BRINE SYSTEM IS INTER-CONNECTED TO MAIN REFRIGERATION PLANT COMPRESSORS.
AC-1: AIR COMPRESSOR	3555b	BAKERY PRODUCTION EQUIPMENT	--	31.5	OPERATES CONTINUALLY WEEKDAY 3AM TO 9PM, ON SATURDAY 3AM TO 2PM.
AC-2: AIR COMPRESSOR	3555b	BAKERY PRODUCTION EQUIPMENT	--	31.5	OPERATES CONTINUALLY WEEKDAY 3AM TO 9PM, ON SATURDAY 3AM TO 2PM.
AC-3: AIR COMPRESSOR	3555b	BAKERY PRODUCTION EQUIPMENT	--	13.0	OPERATES ONLY DURING PEAK LOAD CONDITIONS.
AC-4: AIR COMPRESSOR	3555b	BAKERY PRODUCTION EQUIPMENT	--	13.0	OPERATES ONLY DURING PEAK LOAD CONDITIONS.
AC-5: AIR COMPRESSOR, SIMPLEX	3555b	PRODUCTION EQUIPMENT	--	10.5	OPERATES CONTINUALLY 6AM TO 3PM WEEKDAYS, 10% THE REST OF THE TIME
AC-6: AIR COMPRESSOR, SIMPLEX	3555b	PRODUCTION EQUIPMENT	--	10.5	OPERATES CONTINUALLY 6AM TO 3PM WEEKDAYS, 10% THE REST OF THE TIME
AC-7: AIR COMPRESSOR, SIMPLEX	3555b	PRODUCTION EQUIPMENT	--	10.5	OPERATES CONTINUALLY 6AM TO 3PM WEEKDAYS, 10% THE REST OF THE TIME
AC-8: AIR COMPRESSOR, DUPLEX	3555b	PRODUCTION EQUIPMENT	--	21.0	OPERATES CONTINUALLY 6AM TO 3PM WEEKDAYS, 10% THE REST OF THE TIME
AC-9: AIR COMPRESSOR, DUPLEX	3555b	PRODUCTION EQUIPMENT	--		

UNIT DESCRIPTION	BLDG.	SERVES	MOTOR HP	OPERATING KW	OPERATING SCHEDULE
EC-1: CLOSED CIRCUIT EVAPORATIVE COOLER WITH SPRAY PUMP	3555C	MAIN REFRIGERATION PLANT	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
EC-2: CLOSED CIRCUIT EVAPORATIVE COOLER WITH SPRAY PUMP	3555C	MAIN REFRIGERATION PLANT	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
EC-3: CLOSED CIRCUIT EVAPORATIVE COOLER WITHOUT SPRAY PUMP	3555C	MAIN REFRIGERATION PLANT	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
EC-4: CLOSED CIRCUIT EVAPORATIVE COOLER WITHOUT SPRAY PUMP	3555C	MAIN REFRIGERATION PLANT	10	5.8	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
EC-5: CLOSED CIRCUIT EVAPORATIVE COOLER WITHOUT SPRAY PUMP	3555C	MAIN REFRIGERATION PLANT	10	5.8	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
EC-6: CLOSED CIRCUIT EVAPORATIVE COOLER WITHOUT SPRAY PUMP	3555C	MAIN REFRIGERATION PLANT	10	5.8	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
EC-7: CLOSED CIRCUIT EVAPORATIVE COOLER WITHOUT SPRAY PUMP	3555C	MAIN REFRIGERATION PLANT	10	5.8	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
EC-8: CLOSED CIRCUIT EVAPORATIVE COOLER WITH SPRAY PUMP	3555C	ICE CREAM BRINE REFRIGERATION SYSTEM	3	1.7	UNIT IS NOT OPERATING SINCE REFRIGERATION SYSTEM IS CONNECTED TO CENTRAL REFRIGERATION PLANT
EC-9: CLOSED CIRCUIT EVAPORATIVE COOLER WITH SPRAY PUMP	3555C	NOVELTY STORAGE, BALLY BOX	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
ECP-1: BASE MOUNTED CONDENSER WATER PUMP	3555C	EC-3	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
ECP-2: BASE MOUNTED CONDENSER WATER PUMP	3555C	EC-4	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
ECP-3: BASE MOUNTED CONDENSER WATER PUMP	3555C	EC-5	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK

UNIT DESCRIPTION	BLDG.	SERVES	MOTOR HP	OPERATING KW	OPERATING SCHEDULE
ECP-4: BASE MOUNTED CONDENSER WATER PUMP	3555c	EC-6	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
ECP-5: BASE MOUNTED CONDENSER WATER PUMP	3555c	EC-7	7.5	4.4	FANS RUN CONTINUALLY 24 HRS/DAY, 7 DAYS/WEEK
BP-1: BASE MOUNTED BRINE PUMP	3555c	ICE CREAM BRINE SYSTEM	5	2.9	OPERATES CONTINUALLY 6AM TO 3PM WEEKDAYS, OFF WEEKENDS
BP-2: BASE MOUNTED BRINE PUMP	3555c	ICE CREAM BRINE SYSTEM	--	10.5	OPERATES CONTINUALLY 6AM TO 3PM WEEKDAYS, OFF WEEKENDS
BP-3: BASE MOUNTED BRINE PUMP	3555c	ICE CREAM BRINE SYSTEM	--	10.5	OPERATES CONTINUALLY 6AM TO 3PM WEEKDAYS, OFF WEEKENDS

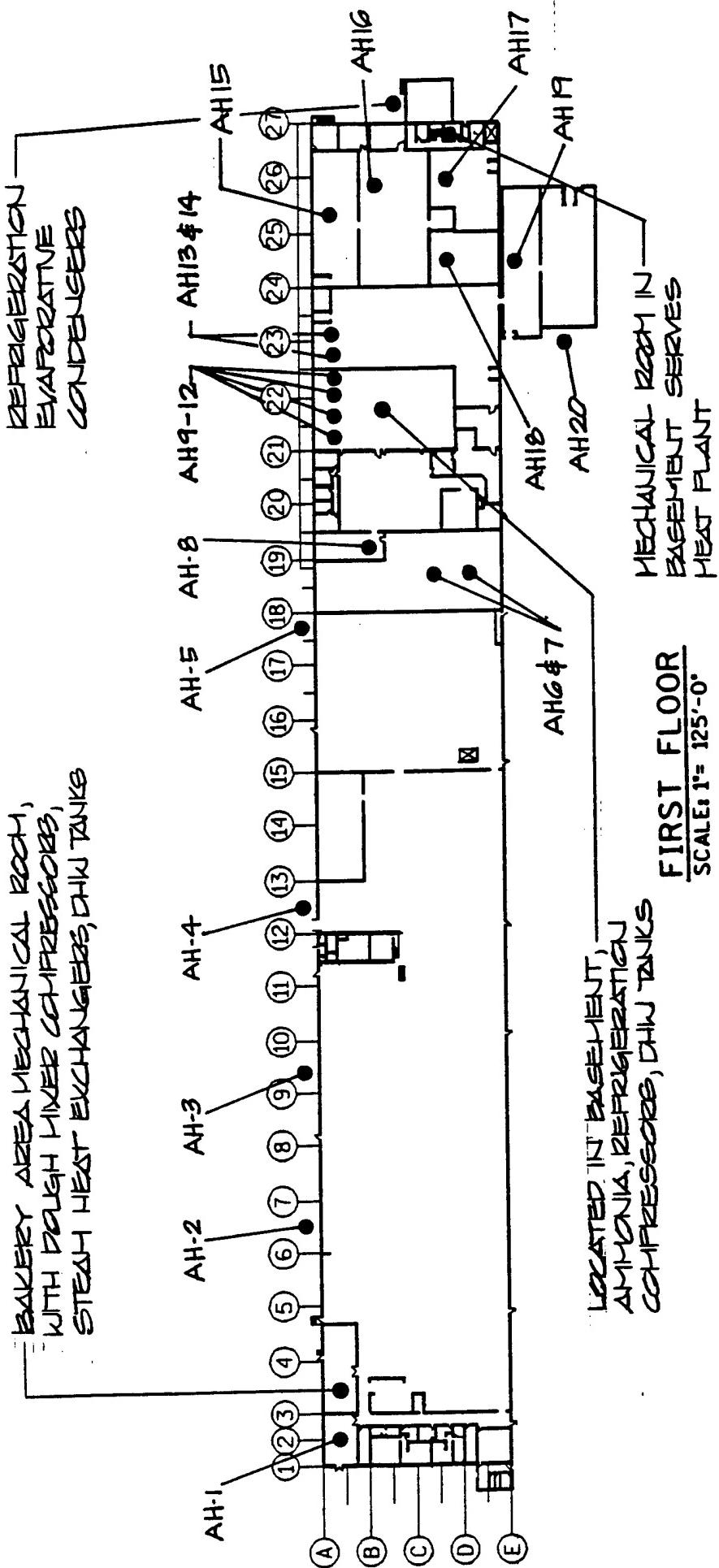


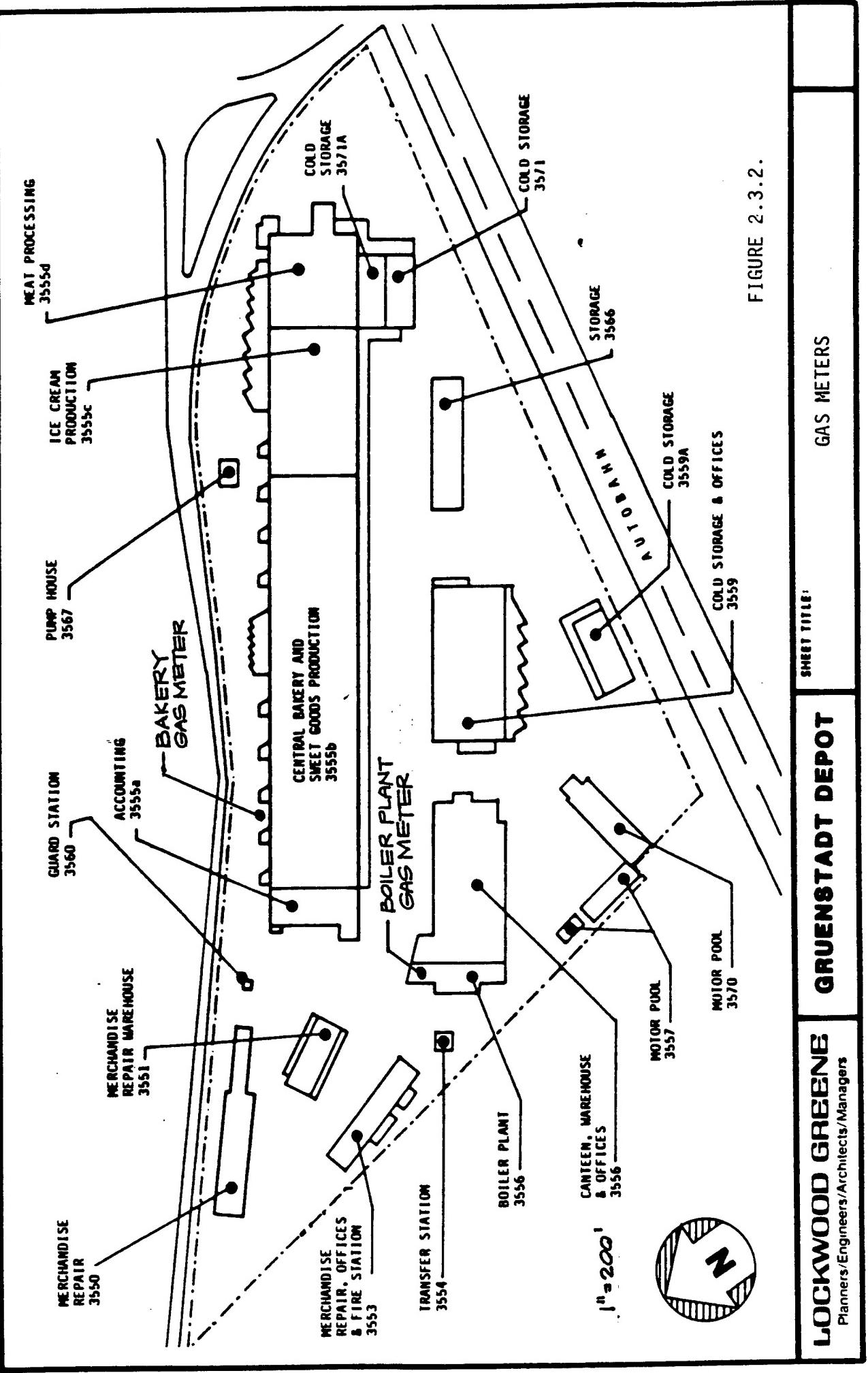
FIGURE: 2.3.1

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SHFT 111 F

BLDG. 3555 MECHANICAL EQUIPMENT



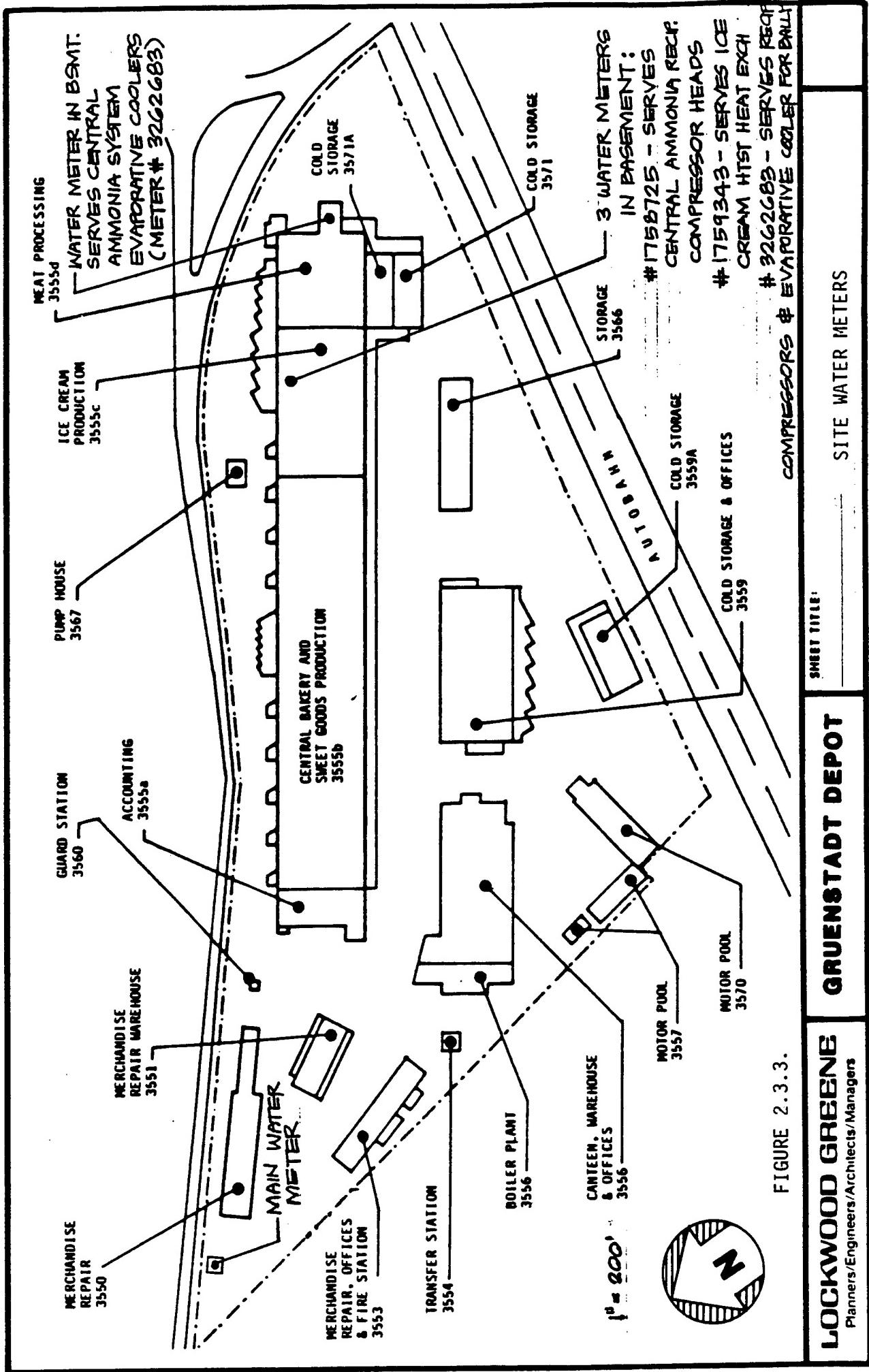


FIGURE 2-3-3.

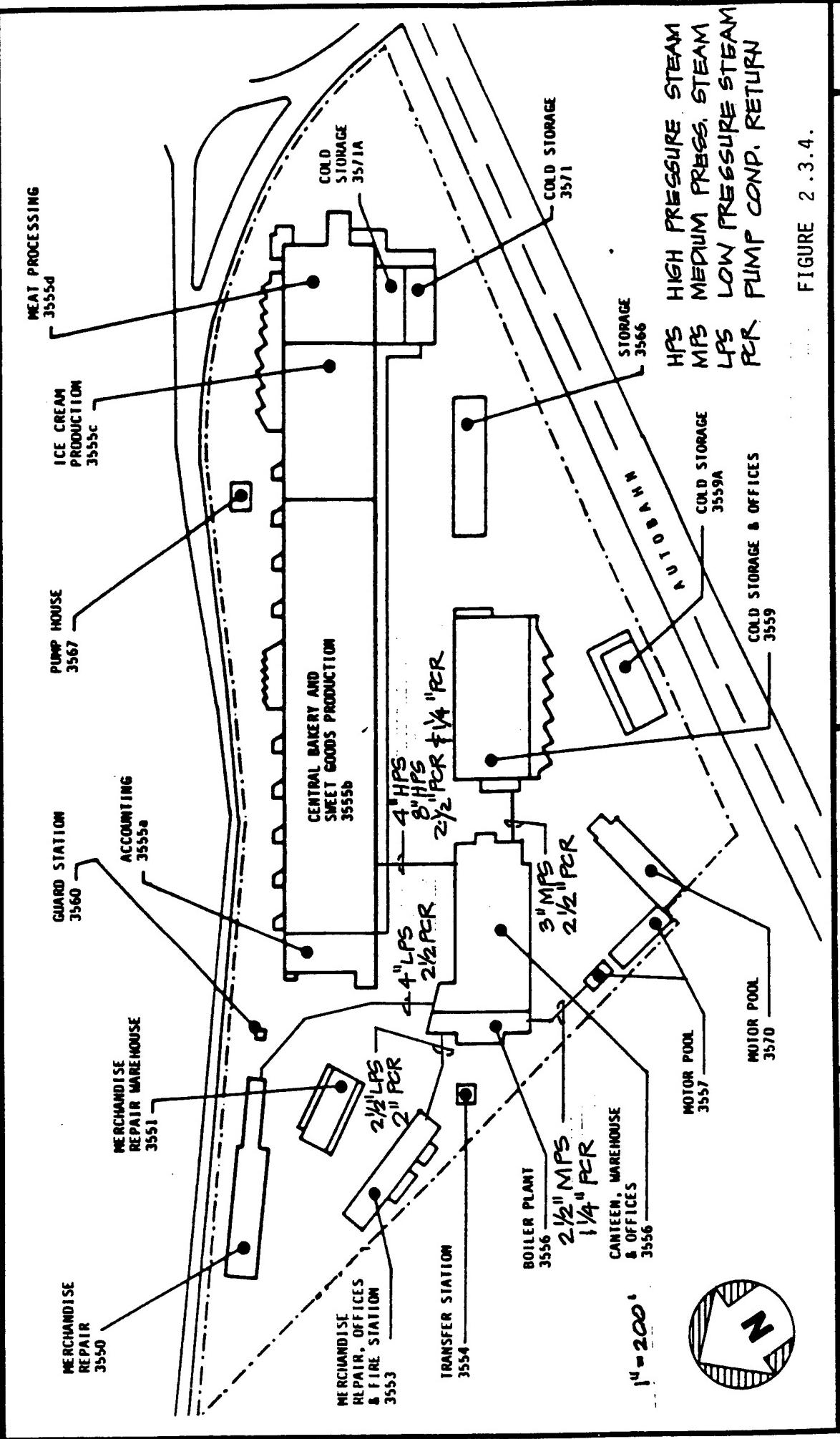


FIGURE 2.3.4.

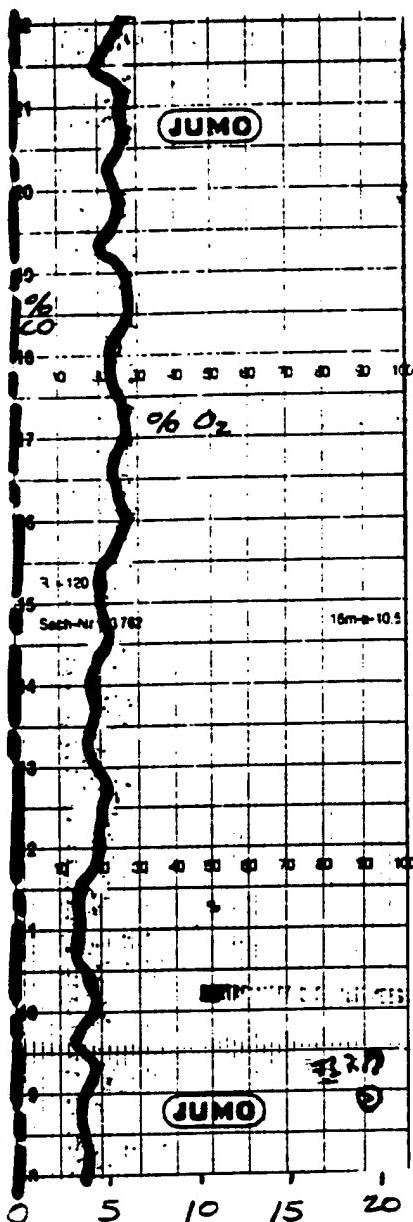
GRUENSTADT DEPOT

LOCKWOOD GREENE
Planners/Engineers/Architects/Managers

Subject: BOILER SYSTEM CHARTS

Date: 5/30/39

13 Jul 88



15 Jan 88

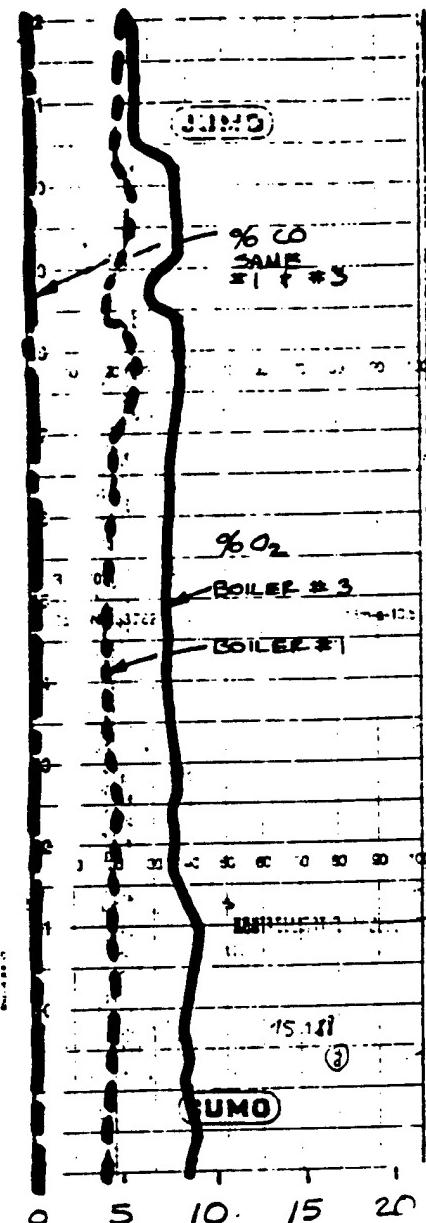


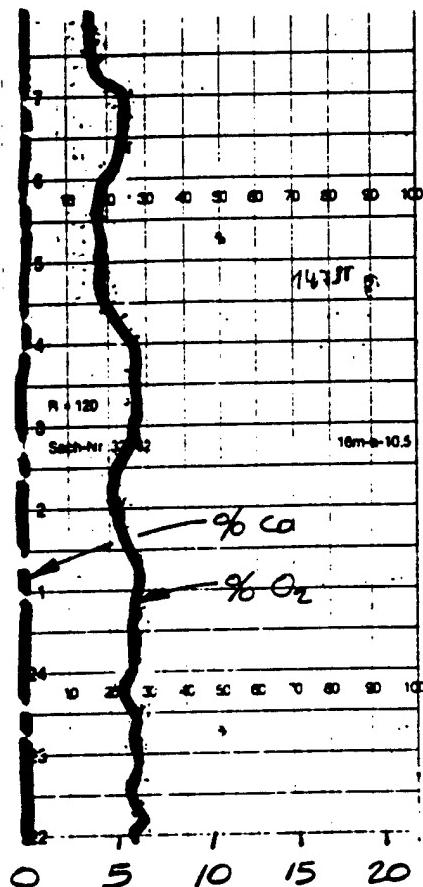
FIGURE 2.3-5 - PERCENT O₂ AND CO

Subject: BOILER SYSTEM CHARTS

Sheet No:

Date: 5/30/89

13 Jul 88



15 Jan 88

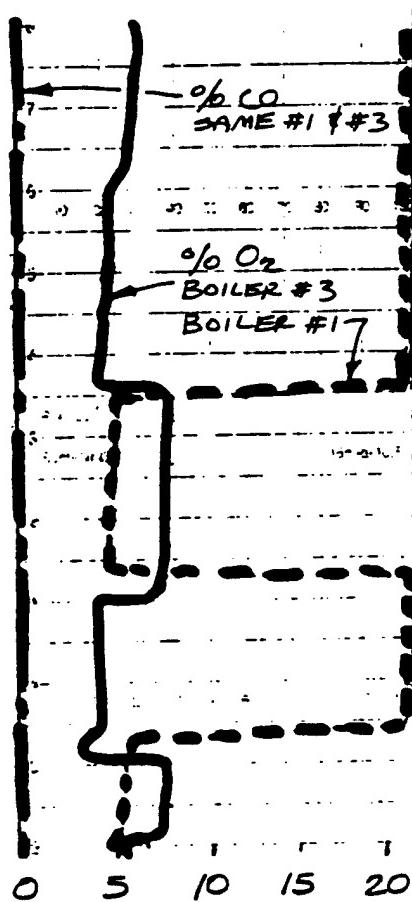
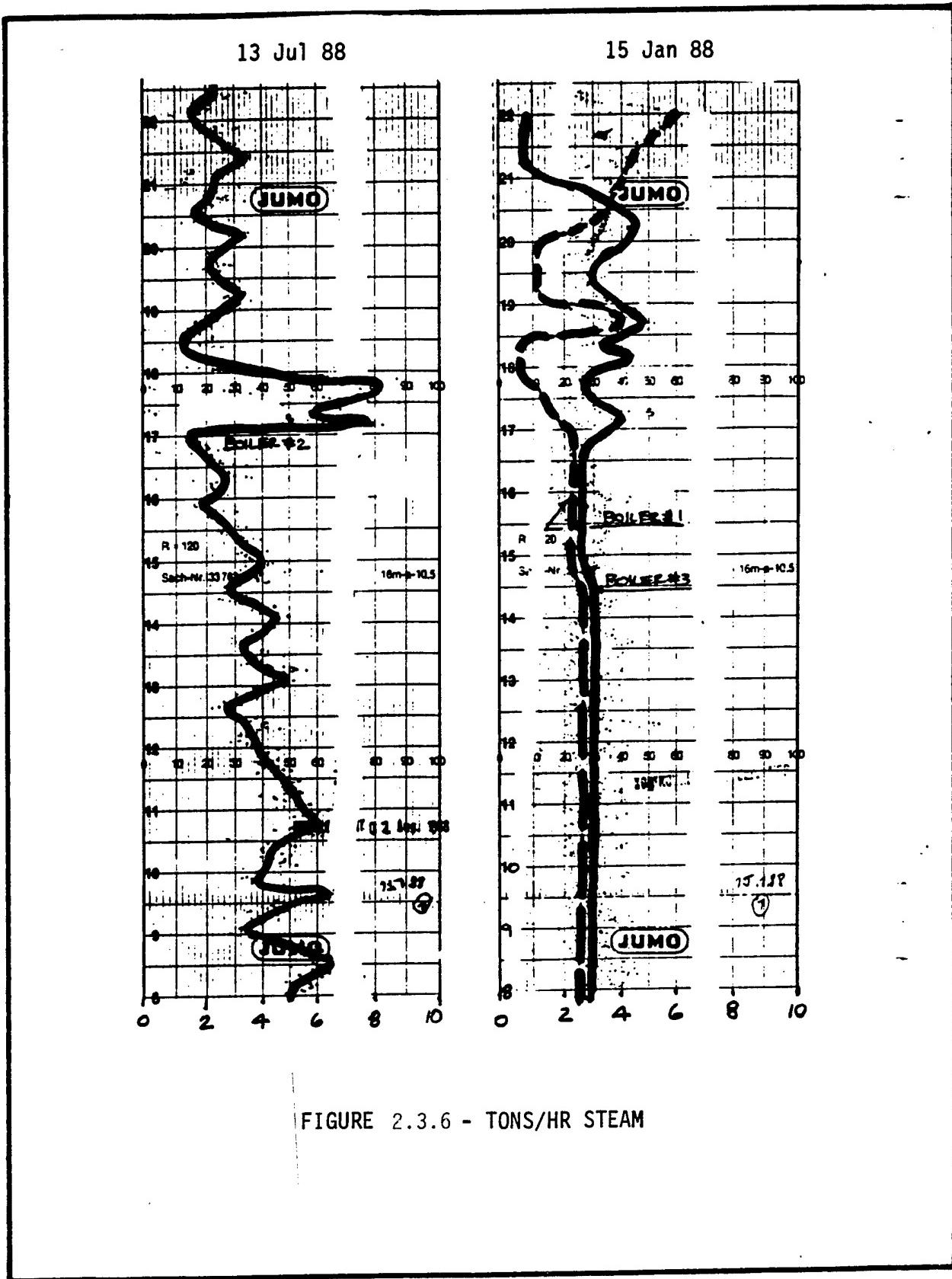


FIGURE 2.3-5 - PERCENT O_2 AND CO

Subject: BOILER SYSTEM CHARTS

Date: 5/30/89



Subject: BOILER SYSTEM CHARTS

Date: 5/30/89

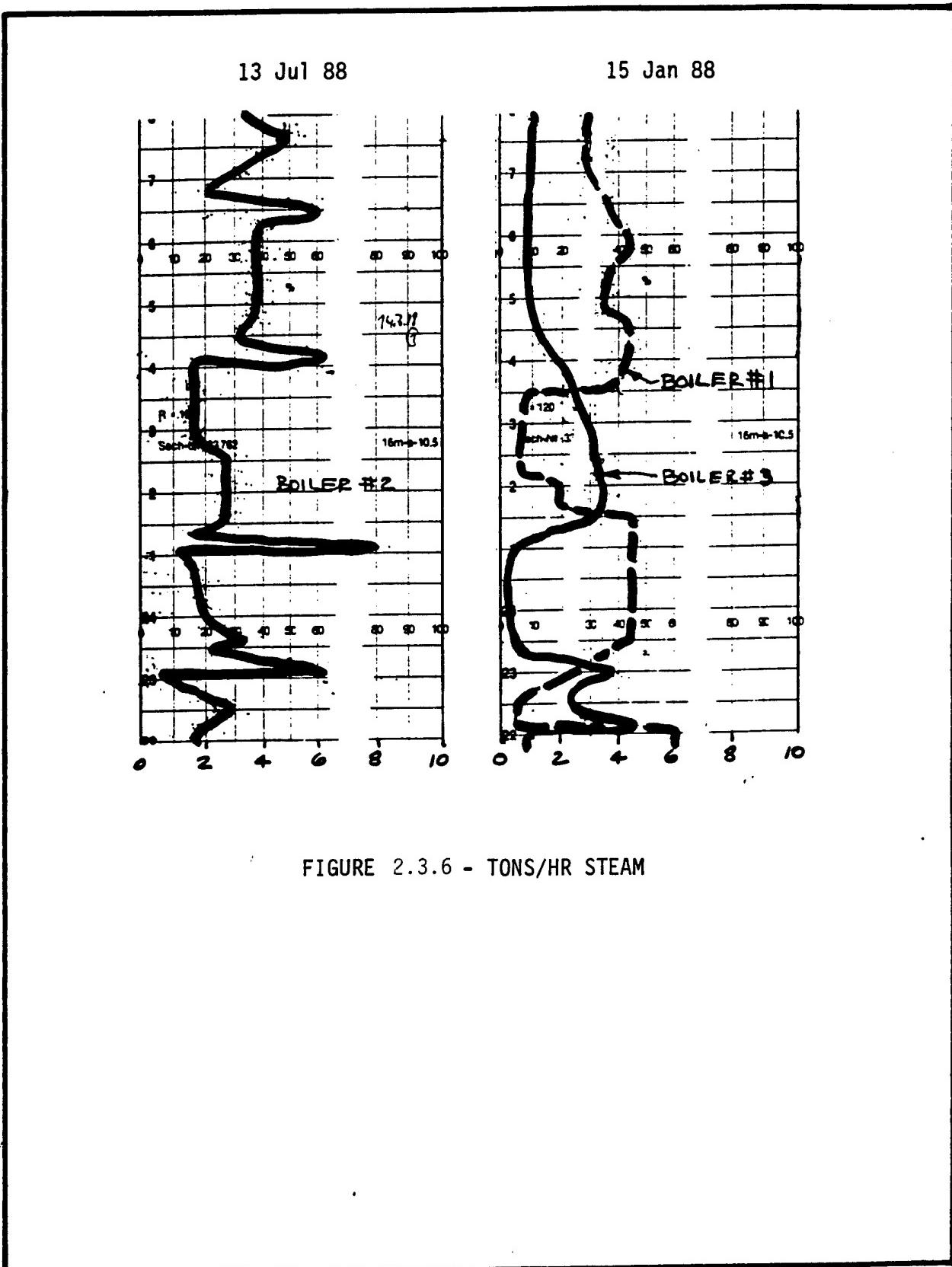


FIGURE 2.3.6 - TONS/HR STEAM

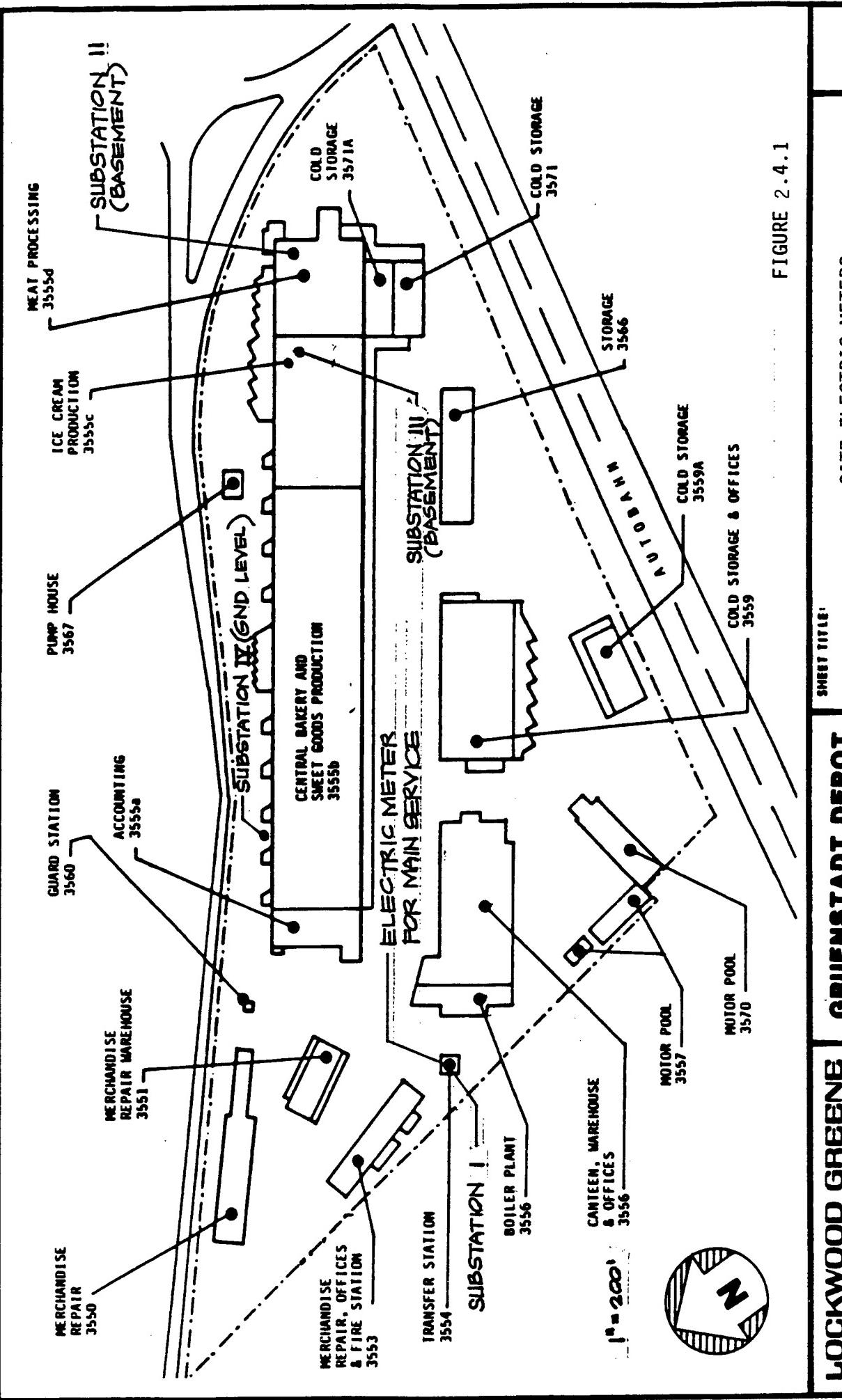


FIGURE 2.4.1

SITE ELECTRIC METERS

- 3.1 SECTION OVERVIEW
- 3.2 TABULATION OF UTILITY BILLS
- 3.3 HISTORICAL UTILITY PROFILE
- 3.4 MONTHLY ELECTRICAL POWER USAGE
- 3.5 MONTHLY BOILER GAS USAGE
- 3.6 MONTHLY BAKERY GAS USAGE
- 3.7 MONTHLY WATER USAGE
- 3.8 FIELD MEASUREMENT OF ELECTRICAL DEMAND

3.1 SECTION OVERVIEW

The purpose of this section is to present the utility data for the facility for the past 3 years, including usage and costs, for electricity, boiler plant natural gas, bakery production natural gas, and water.

Utility bills for each metered utility were gathered for the past 3 years and tabulated for easy reference. Graphs were developed to show the following trends over the past 3 years:

1. Trends in annual utility costs.
2. Trends in annual utility consumption.
3. Trends in monthly energy consumption.
4. Trends in monthly peak electrical demand.
5. Trends in monthly peak gas demand.

Charts of electrical demand developed from field measured data for each of the substations are included in this section. This field measured data helped provide input to the DOE 2.1c computer simulation.

Refer to Section 4 of the Executive Summary for an analysis of the present energy consumption of the facility.

3.2 TABULATION OF UTILITY BILLS

Contractual utility rate information was gathered for each of the utilities studied. This information was used to gain a better understanding of utility bills and accurately assess the cost per unit energy.

Calculations were made to validate the billing methodology. For example, in December, adjustments are made to electrical and gas utility bills to accommodate changes in utility charges.

Summary spreadsheets for electricity, boiler natural gas, bakery natural gas, and water were prepared from utility bills obtained on site. These tables contain pertinent information found within the utility bills for easy reference.

Electrical kilowatt-hours and natural gas cubic feet were converted into a common unit of million British Thermal Units (MMBTU). The summary spreadsheets tabulate both demand and consumption. The data on the spreadsheets allows for graphical presentation of the data for a historical utility profile. The following energy conversion factors were used. These factors are in accordance with ECIP guidelines outlined in the Department of the Army memorandum dated April 25, 1988.

$$\begin{array}{ll} 1 \text{ KWH Electricity} & = 3,413 \text{ BTU (site energy)} \\ 1 \text{ Cubic Foot Natural Gas} & = 1,031 \text{ BTU} \end{array}$$

3.3 HISTORICAL UTILITY PROFILES

The historical utility profile is a comparison of three fiscal years of utility billing data. Utility costs and energy consumption were compared on a monthly and annual basis.

Figure 3.3.1 presents the total annual utility costs for 3 years for electricity, boiler gas, bakery gas, and water. This bar chart reveals that the annual cost of electricity and water has remained fairly constant while the annual cost of boiler and bakery natural gas has dropped in the last two years.

Figure 3.3.2 presents the total annual energy consumption for three years for electricity, boiler gas, and bakery gas. The bar chart indicates that the consumption of both electricity and natural gas has remained level in those three years. Therefore, the decline in annual natural gas costs, reflected in Figure 3.3.2 is not so much a result of energy conservation as a result of declining energy costs.

3.4 MONTHLY ELECTRICAL POWER USAGE

THE Graphs of Figures 3.4.1 and 3.4.2 indicate the monthly KWH consumption and the monthly billed peak KW demand, for the past 3 years. Both graphs show a drop in January. The dip in demand is sharp in January because of the billing methodology. The billed KW each month normally is the average of three months. In January of each year, however, the billed KW does not include the values of months from the previous year. Therefore, the billed KW is lower.

3.5 MONTHLY BOILER GAS USAGE

The graph of Figure 3.5.1 shows consumption of boiler plant gas on a monthly basis, for the past 3 years. The curves for each year all follow the same general pattern, which increases in the winter and drops in the summer. This is reasonable, since the boilers generate steam for heating, domestic hot water, and process steam. Since the process steam and domestic hot water loads remain relatively constant throughout the year, the heating energy is easily identified and quantified.

The amount of heating energy for the facility is easily extracted from Figure 3.5.1. The gas energy consumption from June through August of each month is relatively constant, for the 3 months, and for all three years. This indicates a constant load which is not weather dependent. All energy consumed in these summer months, approximately 3000 MMBTU/MO, is due to process steam loads and domestic water heating. All other gas energy, above 3000 MMBTU/MO, is therefore used for heating.

The graph of Figure 3.5.2 shows the peak billed gas demand for each month, in MMBTU's for the past 3 years. The curves are erratic in shape and do not follow smooth patterns. In addition, the values of peak gas demand do not coincide with the values of peak gas consumption of Figure 3.5.1.

The average monthly gas demand in MMBTUH was calculated by dividing the BTU's used in the month, by the number of hours in a month. This average demand is shown on Figure 3.5.2 at about half of the billed demand value. The difference between the peak gas demand and the average gas demand is the potential in savings in gas demand charges. Gas demand can be reduced by shifting and shedding steam loads where systems permit.

3.6 MONTHLY BAKERY GAS USAGE

The graph of Figures 3.6.1 and 3.6.2 show similar quantities of consumption and demand for bakery production gas, on a monthly basis, for the last 3 years.

3.7 MONTHLY WATER USAGE

The graph of Figure 3.7.1 indicates the same general shape of water usage curve for each of the past 3 years. The annual curves are similar in that consumption in the winter is less than in the summer. The monthly consumption in the winter is consistent from year to year, at approximately 4 million gallons per month. This value is relatively constant for November through February of each year. During the other months, water usage increases and is not consistent from year to year.

3.8 FIELD MEASUREMENT OF ELECTRICAL DEMAND

During the survey, actual measurements of electrical demand were recorded for four different areas. Demand was measured at each of transformer substations 1, 2, 3 and 4. Figures 3.8.1 through 3.8.5 contain graphic profiles of electrical demand for the areas served by these substations.

In brief, transformer substation 2 serves the largest station load. The primary user is the central refrigeration plant compressors of Bldg. 3555. Substation 4 is second in load size and serves the bakery process equipment. Substation 3 serves the sweet goods production area. Substation 1 serves all buildings other than Bldg. 3555.

Following is a more detailed breakdown of the electrical loads served by each transformer substation:

<u>Transformer Substation</u>	<u>Bldg. Number</u>	<u>Load Served</u>
1	3550	Building
	3551	Building
	3552	Building
	3553	Building
	3554	Building
	3555	Accounting, 2nd Floor
	3556	Building
	3557	Building
	3559	Building
	3560	Building
	3566	Building
	3570	Building
	Multi	Exterior Lights
2	3555	All loads east of ice cream plant on ground floor. In basement; all loads except novelty storage and one 200 HP refrigeration machine. About 25 KW in the ice cream plant.
<u>Transformer Substation</u>	<u>Bldg. Number</u>	<u>Load Served</u>
3	3555	On ground floor; light bakery, sweet goods, pizza, ice cream plant, bakery lighting, and novelty storage refrigeration equipment.
4	3555	Bakery (except noted above), 1st floor of west end offices.

PY	MO	DEMAND	YEARLY	PREVIOUS	MONTH'S	ADJUSTMENT	ON-PEAK	ON-PEAK	OFF-PEAK	OFF-PEAK	ON-PEAK	OFF-PEAK	BILLING	
													DM	
86	10	OCT	3,127				788,480		606,640				202,917	
	11	NOV	3,127				601,560		457,480				166,643	
	12	DEC	3,127				613,040		469,600				117,950	
	1	JAN	2,560				708,880		525,600				189,048	
	2	FEB	2,580				564,880		424,800				160,973	
	3	MAR	2,560				637,480		485,680				167,462	
	4	APR	2,653				690,360		508,720				182,881	
	5	MAY	2,760				773,400		583,680				203,999	
	6	JUN	2,932				759,640		555,080				209,694	
	7	JUL	3,013				813,120		615,560				216,673	
	8	AUG	3,080				820,800		615,400				218,325	
	9	SEP	3,080				694,320		524,680				187,069	
		ANNUAL TOTAL					8,465,960		6,372,920				2,223,634	
87	10	OCT	3,080				790,560		594,960				214,726	
	11	NOV	3,080				603,360		455,640				176,688	
	12	DEC	3,080				769,360		410,060				143,398	
	1	JAN	2,420	42,913	0	42,913	2,575	685,400	0.1403	314,680	0.0845	96,162	26,590	168,240
	2	FEB	2,490	88,086	42,913	45,173	2,710	622,520	0.1403	293,000	0.0845	87,340	24,759	159,981
	3	MAR	2,547	134,890	88,086	46,804	(3,262)	869,800	0.1296	436,440	0.0830	112,726	36,225	192,493
	4	APR	2,647	186,312	134,890	51,422	771	736,960	0.1296	554,720	0.0830	95,510	46,042	193,745
	5	MAY	2,733	239,834	186,312	53,522	803	652,840	0.1296	489,840	0.0830	84,608	40,657	179,589
	6	JUN	2,813	295,552	239,834	55,718	834	744,640	0.1296	576,800	0.0830	96,505	47,874	200,931
	7	JUL	2,913	356,113	295,552	60,562	908	835,680	0.1296	656,440	0.0830	108,304	54,485	224,258
	8	AUG	2,913	406,987	356,113	50,873	763	790,440	0.1296	606,880	0.0830	102,441	50,371	204,448
	9	SEP	2,913	457,860	406,987	50,873	763	667,080	0.1296	543,120	0.0830	86,454	45,079	183,169
		ANNUAL TOTAL					8,768,640		5,932,580				2,241,667	
88	10	OCT	2,913	508,733	457,860	50,873	763	858,800	0.1403	407,760	0.0845	120,490	34,456	206,582
	11	NOV	2,913	559,607	508,733	50,873	(7,631)	745,600	0.1403	353,040	0.0845	104,608	29,832	177,682
	12	DEC	2,743	577,539	559,607	17,932		813,400	0.1403	392,040	0.0845	114,120	33,127	165,180
	1	JAN	2,620	46,142	0	46,142		722,520	0.1403	338,560	0.0845	101,370	28,608	176,120
	2	FEB	2,610	91,961	46,142	45,819		797,600	0.1403	366,520	0.0845	111,903	30,971	188,693
	3	MAR	2,647	139,734	91,961	47,773		840,000	0.1296	556,640	0.0830	108,864	46,201	202,838
	4	APR	2,693	189,284	139,734	49,549		638,160	0.1296	483,120	0.0830	82,706	40,099	172,354
	5	MAY	2,753	241,449	189,284	52,165		756,760	0.1296	576,400	0.0830	98,076	47,841	198,082
	6	JUN	2,913	305,240	241,449	63,791		779,160	0.1296	612,000	0.0830	100,979	50,796	215,566
	7	JUL	3,027	368,904	305,240	63,664		808,520	0.1296	642,240	0.0830	104,784	53,306	221,754
	8	AUG	3,107	431,616	368,904	62,712	6,474	787,360	0.1296	631,040	0.0830	102,042	52,376	223,604
*	9	SEP	2,820	444,345	431,616	12,729	-	772,267	0.1296	618,941	0.0830	100,086	51,372	164,186
		ANNUAL TOTAL					9,320,147		5,978,301				2,312,642	

* Usage is based upon telephone conversation with Worms on March 30, 1989.
Charges are based upon AUG 88 cost/kW and cost/kWh.

Gruenstadt Energy Audit
U.S. Army Corps of Engineers

SUMMARY OF BAKERY GAS UTILITY BILLS
(3 YEARS, FY86-FY88)

Lockwood Greene
Dallas, Texas

FY	MO	DEMAND KW	RATE DM/KW	DEMAND DM	USAGE CBM	KWH FACTOR	EQUIV KWH	RATE DM/KWH	USAGE DM	BILLING DM
86	OCT			3,137	44,728	11.176	499,869	0.054760	27,373	30,510
	NOV			3,137	35,943	10.918	392,426	0.054760	21,489	24,627
	DEC			4,631	36,003	11.071	398,589	0.054760	21,827	26,458
	JAN	1,863	18.797	2,918	43,382	11.053	479,501	0.054760	26,257	29,176
	FEB	1,858	18.797	2,910	38,497	11.088	426,855	0.054760	23,375	26,285
	MAR	1,836	18.797	2,876	40,553	11.102	450,219	0.054760	24,654	27,530
	APR	1,864	18.797	2,920	42,623	11.084	472,433	0.049040	23,168	26,088
	MAY	1,919	18.797	3,006	42,896	11.108	476,489	0.049040	23,367	26,373
	JUN	1,892	18.797	2,964	42,288	11.123	470,369	0.049040	23,067	26,031
	JUL	1,855	18.797	2,906	41,856	11.124	465,606	0.049040	22,833	25,739
	AUG	1,871	18.797	2,931	39,076	11.113	434,252	0.049040	21,296	24,226
	SEP	1,899	18.797	2,975	41,857	11.098	464,529	0.049040	22,781	25,755
	ANNUAL TOTAL				489,702		5,431,138		281,486	318,798
87	OCT	1,940	19.120	3,091	45,301	11.084	502,116	0.033970	17,057	20,148
	NOV	1,886	19.120	3,005	39,786	11.093	441,346	0.033970	14,993	17,998
	DEC	1,930	ADJUST	3,933	39,431	11.105	437,881	0.033970	14,875	18,808
	JAN	1,742	19.120	2,776	43,587	11.043	481,331	0.026140	12,582	15,358
	FEB	1,745	19.120	2,780	41,703	10.976	457,732	0.026140	11,965	14,745
	MAR	1,750	19.120	2,788	45,148	10.975	495,499	0.026140	12,952	15,741
	APR	1,759	19.120	2,803	43,934	11.052	485,559	0.024050	11,678	14,480
	MAY	1,750	19.120	2,788	43,528	11.090	482,726	0.024050	11,610	14,398
	JUN	1,791	19.120	2,854	45,637	11.121	507,529	0.024050	12,206	15,060
	JUL	1,850	19.120	2,948	47,323	11.142	527,273	0.026290	13,862	16,810
	AUG	1,908	19.120	3,040	44,109	11.167	492,565	0.026290	12,950	15,990
	SEP	2,159	19.120	3,440	48,272	11.150	538,233	0.026290	14,150	17,590
	ANNUAL TOTAL				527,759		5,849,790			197,124
88	OCT	1,853	19.413	2,998	47,158	11.087	522,841	0.027230	14,237	17,235
	NOV	1,814	19.413	2,935	46,832	11.030	516,557	0.027230	14,066	17,000
	DEC	2,034	ADJUST	6,890	48,353	11.061	534,833	0.027230	14,563	21,454
	JAN	1,797	19.413	2,907	44,502	11.020	490,412	0.026920	13,202	16,109
	FEB	1,811	19.413	2,930	47,071	11.000	517,781	0.026920	13,939	16,868
	MAR	1,869	19.413	3,024	51,474	11.060	569,302	0.026920	15,326	18,349
	APR	1,892	19.413	3,061	47,206	11.080	523,042	0.026600	13,913	16,974
	MAY	1,799	19.413	2,910	50,960	11.146	568,000	0.026600	15,109	18,019
	JUN	1,724	19.413	2,789	51,562	11.121	573,421	0.026600	15,253	18,042
	JUL	1,811	19.413	2,930	50,871	11.125	565,940	0.024410	13,815	16,744
	AUG	1,874	19.413	3,032	54,141	11.130	602,589	0.024410	14,709	17,741
	SEP				54,313		501,381			14,761 *
	ANNUAL TOTAL				594,443		648,6099			209,296

Usage is based upon telephone conversation with Worms on March 30, 1989.
Charge is based upon average for AUG 88 DM/KWH.

Gruenstadt Energy Audit
U.S. Army Corps of Engineers

SUMMARY OF BOILER GAS UTILITY BILLS
(3 YEARS, FY86-FY88)

Lockwood Greene
Dallas, Texas

PY	MONTH	Demand kW	Rate DM/kW	KW Charge DM	Usage CBM	KWH Factor	Equal KWH	Rate DM/kwh	KWH Charge DM	Billing DM
86	OCT				114,730		1,271,838			70,867 *
	NOV	4,071	18.797	6,377	109,322	10.923	1,194,124	0.05038	60,160	66,537
	DEC	3,801	18.797	5,954	146,162	11.073	1,618,452	0.05038	81,538	87,492
	JAN	4,461	18.797	6,988	160,990	11.055	1,779,744	0.05038	89,664	96,651
	FEB	5,112	18.797	8,008	157,395	11.087	1,745,038	0.05038	87,915	95,923
	MAR	4,516	18.797	7,074	150,609	11.101	1,671,911	0.05038	84,231	91,305
	APR	4,214	18.797	6,601	143,438	11.087	1,590,297	0.04511	71,738	78,339
	MAY	3,132	18.797	4,906	103,773	11.107	1,152,607	0.04511	51,994	56,900
	JUN	3,773	18.797	5,910	98,559	11.124	1,096,370	0.04511	49,457	55,367
	JUL	3,042	18.797	4,765	90,496	11.124	1,006,678	0.04511	45,411	50,176
	AUG	2,972	18.797	4,655	86,156	11.113	957,452	0.04511	43,191	47,846
	SEP	3,120	18.797	4,887	92,830	11.099	1,030,320	0.04511	46,478	51,365
	ANNUAL TOTAL						16,114,831			848,768
87	OCT	3,679	19.120	5,862	117,680	11.085	1,304,483	0.03125	40,765	46,627
	NOV	3,616	19.120	5,761	125,098	11.093	1,387,712	0.03125	43,366	49,127
	DEC	4,814	ADJUST	25,460	140,797	11.103	1,563,269	0.03125	48,852	74,312
	JAN	4,945	19.120	7,879	168,377	11.041	1,859,050	0.02405	44,710	52,589
	FEB	4,073	19.120	6,490	141,558	10.979	1,554,165	0.02405	37,378	43,867
	MAR	3,939	19.120	6,276	146,745	10.976	1,610,673	0.02405	38,737	45,013
	APR	3,747	19.120	5,970	121,840	11.049	1,346,210	0.02213	29,792	35,762
	MAY	3,822	19.120	6,090	111,635	11.090	1,238,032	0.02213	27,398	33,487
	JUN	2,921	19.120	4,654	89,311	11.121	993,228	0.02213	21,980	26,634
	JUL	2,468	19.120	3,932	85,153	11.145	949,030	0.02418	22,948	26,880
	AUG	3,202	19.120	5,102	85,331	11.165	952,721	0.02418	23,037	28,139
	SEP	3,062	19.120	4,879	84,215	11.148	938,829	0.02418	22,701	27,580
	ANNUAL TOTAL				1,417,740		15,697,402			490,018
88	OCT	3,458	19.413	5,594	111,780	11.086	1,239,193	0.02505	31,042	36,636
	NOV	3,547	19.413	5,738	122,502	11.032	1,351,442	0.02505	33,854	39,592
	DEC	4,509	ADJUST	23,938	137,203	11.061	1,517,602	0.02505	38,016	61,954
	JAN	3,478	19.413	5,627	131,221	11.024	1,446,580	0.02477	35,832	41,458
	FEB	3,624	19.413	5,863	129,693	11.001	1,426,753	0.02477	35,341	41,203
	MAR	3,890	19.413	6,293	130,388	11.061	1,442,222	0.02477	35,724	42,017
	APR	3,306	19.413	5,348	104,659	11.080	1,159,622	0.02448	28,388	33,736
	MAY	3,076	19.413	4,976	94,643	11.149	1,055,175	0.02448	25,831	30,807
	JUN	2,365	19.413	3,826	87,813	11.122	976,656	0.02448	23,909	27,735
	JUL	2,571	19.413	4,159	88,074	11.126	979,911	0.02246	22,009	26,168
	AUG	2,579	19.413	4,172	88,619	11.129	986,241	0.02246	22,151	26,323
	SEP				89,942		1,000,965			26,716 **
	ANNUAL TOTAL				1,316,537		14,582,362			434,345

* Usage is based upon an average of CBM for OCT of FY87 & FY88.
Costs are based upon NOV of FY86 overall DM/kwh.

** Usage is based upon telephone conversation with Worms on March 30, 1989.
Charge is based upon average for AUG 88 DM/kwh.

Gruenstadt Energy Audit
U.S. Army Corps of Engineers

SUMMARY OF WATER UTILITY BILLS
(3 YEARS, FY86-FY88)

Lockwood Greene
Dallas, Texas

FY	MONTH	COOLING CBM	NORMAL CBM	TOTAL CBM	1ST INCR DM/CBM	2ND INCR DM/CBM	BILLING DM
86	OCT	10,848	11,896	22,744	1.53	1.53	34,798
	NOV	7,814	8,571	16,385	1.53	1.53	25,069
	DEC	6,944	7,942	14,886	1.53	1.53	22,776
	JAN	7,551	9,406	16,957	1.70	1.53	27,644
	FEB	7,812	9,243	17,055	1.53	1.53	26,094
	MAR	7,343	9,324	16,667	1.53	1.53	25,501
	APR	9,599	10,941	20,540	1.53	1.53	31,426
	MAY	9,569	10,569	20,138	1.53	1.53	30,811
	JUN	10,512	12,864	23,376	1.53	1.53	35,765
	JUL	12,974	12,988	25,962	1.53	1.53	39,722
	AUG	9,091	15,550	24,641	1.53	1.53	37,701
	SEP	12,356	6,324	18,680	1.53	1.53	28,580
	TOTAL	112,413	125,618	238,031			365,887
87	OCT	11,902	7,814	19,716	1.53	1.53	30,165
	NOV	6,401	9,053	15,454	1.53	1.53	23,645
	DEC	6,847	7,477	14,324	1.53	1.53	21,916
	JAN	7,166	10,206	17,372	1.70	1.53	28,279
	FEB	7,305	9,962	17,267	1.53	1.53	26,419
	MAR	9,294	9,678	18,972	1.53	1.53	29,027
	APR	8,640	10,913	19,553	1.53	1.53	29,916
	MAY	7,896	9,810	17,706	1.53	1.53	27,090
	JUN	10,854	9,941	20,795	1.53	1.53	31,816
	JUL	11,850	12,470	24,320	1.53	1.53	37,210
	AUG	9,090	10,925	20,015	1.53	1.53	30,623
	SEP	9,514	10,725	20,239	1.53	1.53	30,966
	TOTAL	106,759	118,974	225,733			347,071
88	OCT	9,276	11,132	20,408	1.53	1.53	31,224
	NOV	8,076	8,830	16,906	1.53	1.53	25,866
	DEC	7,241	9,263	16,504	1.53	1.53	25,251
	JAN	6,368	8,851	15,219	1.70	1.53	24,985
	FEB	7,067	9,649	16,716	1.53	1.53	25,575
	MAR	8,848	12,627	21,475	1.53	1.53	32,857
	APR	9,936	7,978	17,914	1.53	1.53	27,408
	MAY	10,108	11,642	21,750	1.53	1.53	33,278
	JUN	13,382	8,479	21,861	1.53	1.53	33,447
	JUL	7,908	13,679	21,587	1.53	1.53	33,028
	AUG	12,632	12,661	25,293	1.53	1.53	38,698
*	SEP			21,861			33,447 **
	TOTAL			237,494			365,065

* Usage is based upon telephone conversation with Worms on March 30, 1989.

** Charge is based upon average for AUG 88 DM/CBM.

ELECTRICAL UNIT CONVERSIONS

Gruenstadt Energy Audit
U.S. Army Corps of Engineers

Lockwood Greene
Dallas, Texas

	FY 86		FY 87		FY 88	
MONTH	USAGE (KWH)	ENERGY (MMBTU)	USAGE (KWH)	ENERGY (MMBTU)	USAGE (KWH)	ENERGY (MMBTU)
OCT	1,395,120	4,762	1,385,520	4,729	1,266,560	4,323
NOV	1,059,040	3,615	1,059,000	3,614	1,098,640	3,750
DEC	1,082,640	3,695	1,179,420	4,025	1,205,440	4,114
JAN	1,234,480	4,213	1,000,080	3,413	1,061,080	3,621
FEB	989,680	3,378	915,520	3,125	1,164,120	3,973
MAR	1,123,160	3,833	1,306,240	4,458	1,396,640	4,767
APR	1,199,080	4,092	1,291,680	4,409	1,121,280	3,827
MAY	1,357,080	4,632	1,142,680	3,900	1,333,160	4,550
JUN	1,314,720	4,487	1,321,440	4,510	1,391,160	4,748
JUL	1,428,680	4,876	1,492,120	5,093	1,450,760	4,951
AUG	1,436,200	4,902	1,397,320	4,769	1,418,400	4,841
SEP	1,219,000	4,160	1,210,200	4,130	1,391,211	4,748
TOTAL	14,838,880	50,645	14,701,220	50,175	15,298,451	52,214

BAKERY GAS UNIT CONVERSIONS

**Gruenstadt Energy Audit
U.S. Army Corps of Engineers**

**Lockwood Greene
Dallas, Texas**

MONTH	FY 86			FY 87			FY 88		
	USAGE (CBM)	USAGE (MCF)	ENERGY (MMBTU)	USAGE (CBM)	USAGE (MCF)	ENERGY (MMBTU)	USAGE (CBM)	USAGE (MCF)	ENERGY (MMBTU)
OCT	44,728	1,579	1,627	45,301	1,600	1,648	47,158	1,665	1,715
NOV	35,943	1,269	1,307	39,786	1,405	1,447	46,832	1,654	1,703
DEC	36,003	1,271	1,309	39,431	1,392	1,434	48,353	1,707	1,759
JAN	43,382	1,532	1,578	43,587	1,539	1,585	44,502	1,571	1,619
FEB	38,497	1,359	1,400	41,703	1,473	1,517	47,071	1,662	1,712
MAR	40,553	1,432	1,475	45,148	1,594	1,642	51,474	1,818	1,872
APR	42,623	1,505	1,550	43,934	1,551	1,598	47,206	1,667	1,717
MAY	42,896	1,515	1,560	43,528	1,537	1,583	50,960	1,799	1,853
JUN	42,288	1,493	1,538	45,637	1,611	1,660	51,562	1,821	1,875
JUL	41,856	1,478	1,522	47,323	1,671	1,721	50,871	1,796	1,850
AUG	39,076	1,380	1,421	44,109	1,557	1,604	54,141	1,912	1,969
SEP	41,857	1,478	1,522	48,272	1,704	1,756	54,313	1,918	1,975
ANNUAL TOTAL	489,702	17,291	17,810	527,759	18,635	19,194	594,443	20,990	21,619

BOILER PLANT NATURAL GAS UNIT CONVERSIONS

Gruenstadt Energy Audit
U.S. Army Corps of Engineers

Lockwood Greene
Dallas, Texas

	FY 86			FY 87			FY 88		
MONTH	USAGE (CBM)	USAGE (MCF)	ENERGY (MMBTU)	USAGE (CBM)	USAGE (MCF)	ENERGY (MMBTU)	USAGE (CBM)	USAGE (MCF)	ENERGY (MMBTU)
OCT	114,730	4,051	4,173	117,680	4,155	4,280	111,780	3,947	4,065
NOV	109,322	3,860	3,976	125,098	4,417	4,550	122,502	4,326	4,455
DEC	146,162	5,161	5,316	140,797	4,972	5,121	137,203	4,845	4,990
JAN	166,990	5,896	6,073	168,377	5,945	6,124	131,221	4,633	4,772
FEB	157,395	5,558	5,724	141,558	4,998	5,148	129,693	4,579	4,717
MAR	150,609	5,318	5,478	146,745	5,182	5,337	130,388	4,604	4,742
APR	143,438	5,065	5,217	121,840	4,302	4,431	104,659	3,696	3,806
MAY	103,773	3,664	3,774	111,635	3,942	4,060	94,643	3,342	3,442
JUN	98,559	3,480	3,585	89,311	3,154	3,248	87,813	3,101	3,194
JUL	90,496	3,195	3,291	85,153	3,007	3,097	88,074	3,110	3,203
AUG	86,156	3,042	3,133	85,331	3,013	3,103	88,619	3,129	3,223
SEP	92,830	3,278	3,376	84,215	2,974	3,063	89,942	3,176	3,271
TOTAL	1,460,460	51,569	53,116	1,417,740	50,060	51,562	1,316,537	46,487	47,882

TOTALIZED MONTHLY AND ANNUAL MMBTU
COMBINED UTILITIES

Gruenstadt Energy Audit
U.S. Army Corps of Engineers

Lockwood Greene
Dallas, Texas

PY	MONTH	BAKERY		BOILER		TOTAL	
		ELEC (MMBTU)	GAS (MMBTU)	GAS (MMBTU)	GAS (MMBTU)	TOTAL (MMBTU)	
86	OCT	4,762	1,627	4,173	5,800	10,562	
	NOV	3,615	1,307	3,976	5,283	8,898	
	DEC	3,695	1,309	5,316	6,625	10,320	
	JAN	4,213	1,578	6,073	7,651	11,864	
	FEB	3,378	1,400	5,724	7,124	10,502	
	MAR	3,833	1,475	5,478	6,953	10,786	
	APR	4,092	1,550	5,217	6,767	10,859	
	MAY	4,632	1,560	3,774	5,334	9,966	
	JUN	4,487	1,538	3,585	5,123	9,610	
	JUL	4,876	1,522	3,291	4,813	9,689	
	AUG	4,902	1,421	3,133	4,554	9,456	
	SEP	4,160	1,522	3,376	4,898	9,058	
	ANNUAL TOTAL	50,645	17,809	53,116	70,925	121,570	
87	OCT	4,729	1,648	4,280	5,928	10,657	
	NOV	3,614	1,447	4,550	5,997	9,611	
	DEC	4,025	1,434	5,121	6,555	10,580	
	JAN	3,413	1,585	6,124	7,709	11,122	
	FEB	3,125	1,517	5,148	6,665	9,790	
	MAR	4,458	1,642	5,337	6,979	11,437	
	APR	4,409	1,598	4,431	6,029	10,438	
	MAY	3,900	1,583	4,060	5,643	9,543	
	JUN	4,510	1,660	3,248	4,908	9,418	
	JUL	5,093	1,721	3,097	4,818	9,911	
	AUG	4,769	1,604	3,103	4,707	9,476	
	SEP	4,130	1,756	3,063	4,819	8,949	
	ANNUAL TOTAL	50,175	19,195	51,562	70,757	120,932	
88	OCT	4,323	1,715	4,065	5,780	10,103	
	NOV	3,750	1,703	4,455	6,158	9,908	
	DEC	4,114	1,759	4,990	6,749	10,863	
	JAN	3,621	1,619	4,772	6,391	10,012	
	FEB	3,973	1,712	4,717	6,429	10,402	
	MAR	4,767	1,872	4,742	6,614	11,381	
	APR	3,827	1,717	3,806	5,523	9,350	
	MAY	4,550	1,853	3,442	5,295	9,845	
	JUN	4,748	1,875	3,194	5,069	9,817	
	JUL	4,951	1,850	3,203	5,053	10,004	
	AUG	4,841	1,969	3,223	5,192	10,033	
	SEP	4,748	1,975	3,271	5,246	9,994	
	ANNUAL TOTAL	52,213	21,619	47,880	69,499	121,712	
	3YR TOTAL	153,033	58,623	152,558	211,181	364,214	

FIGURE 3.3.1 - ANNUAL UTILITY COSTS

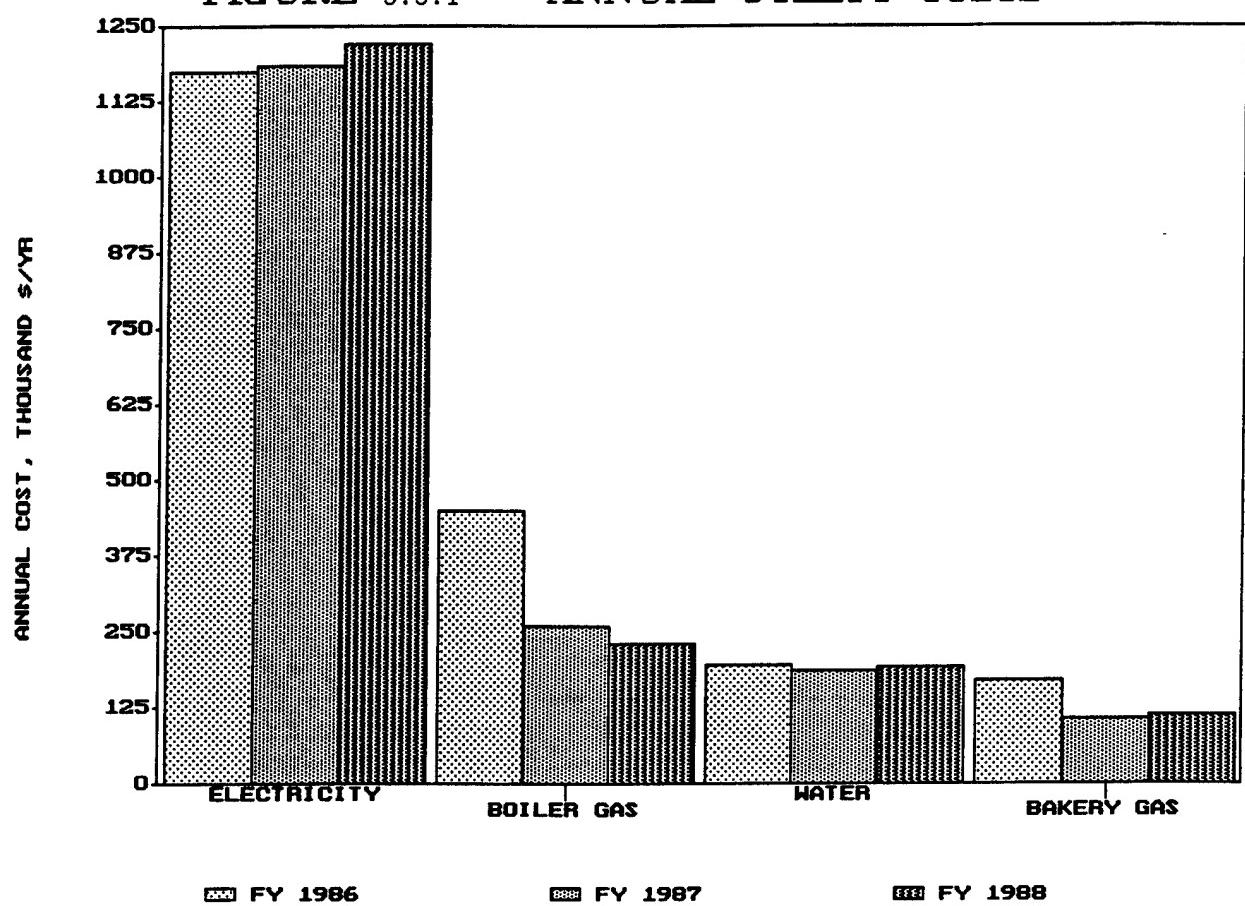


FIGURE 3.3.2 - ANNUAL ENERGY CONSUMPTION

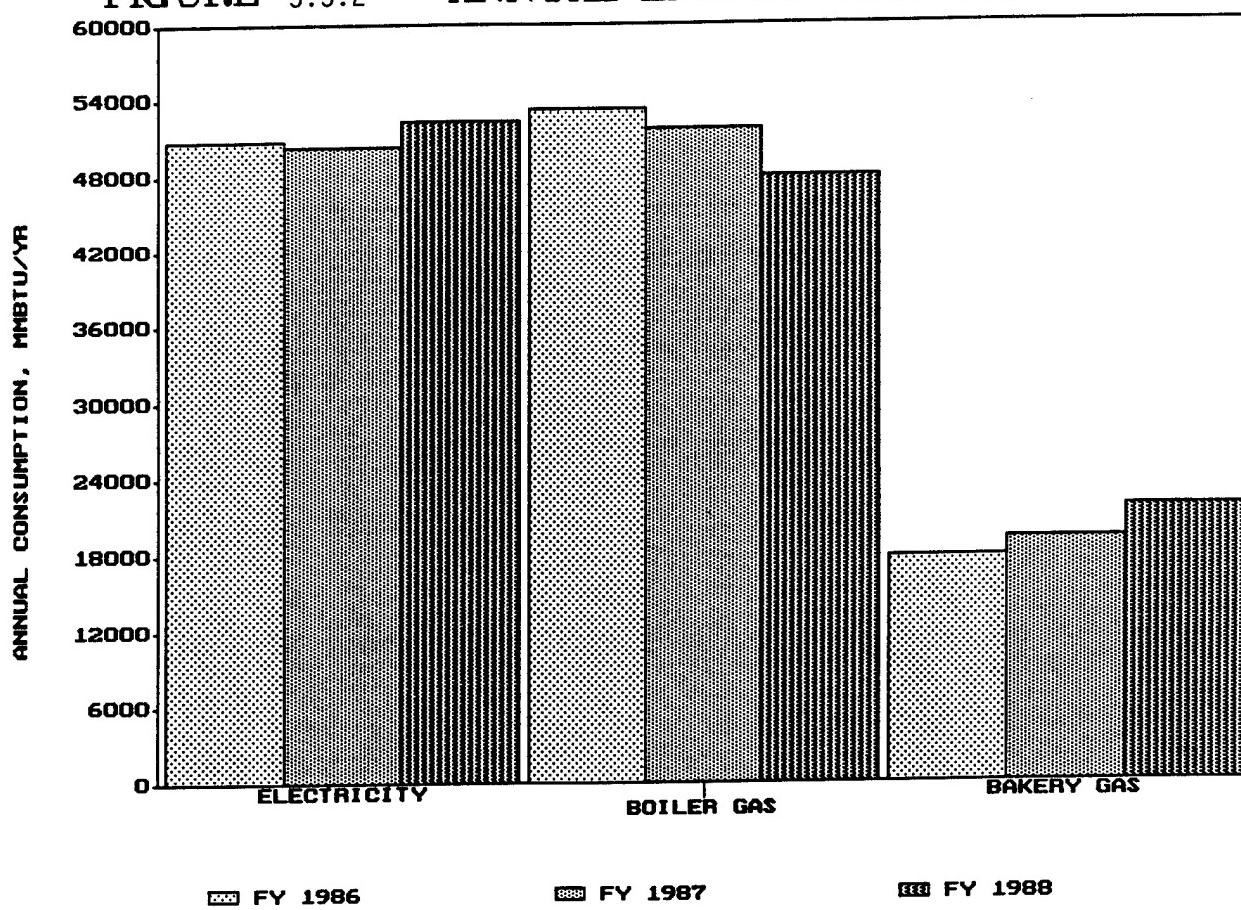


FIGURE 3.4.1 GRUENSTADT UTILITY HISTORY
ELECTRICITY

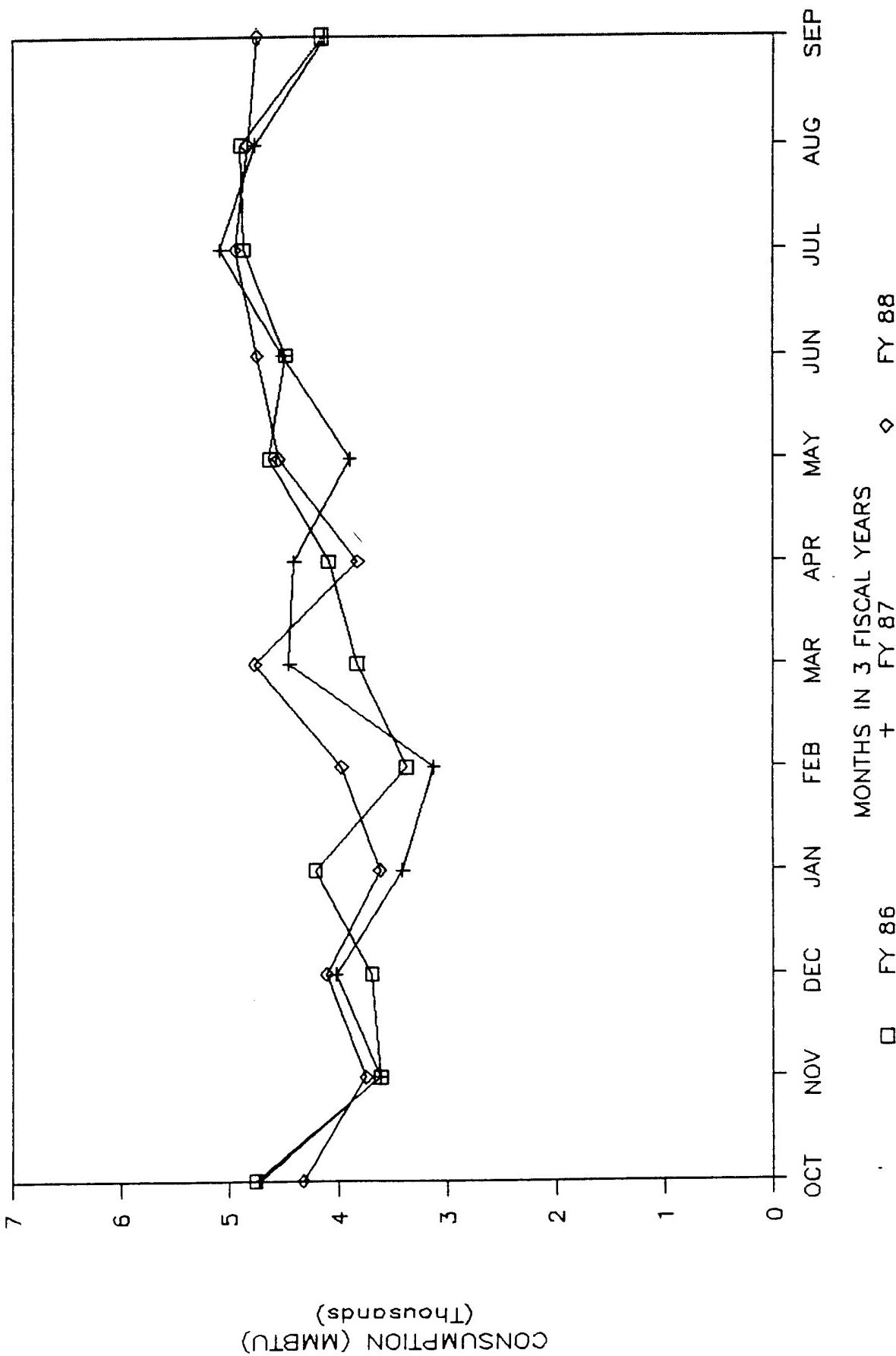


FIGURE 3.4.2

GRUENSTADT UTILITY HISTORY

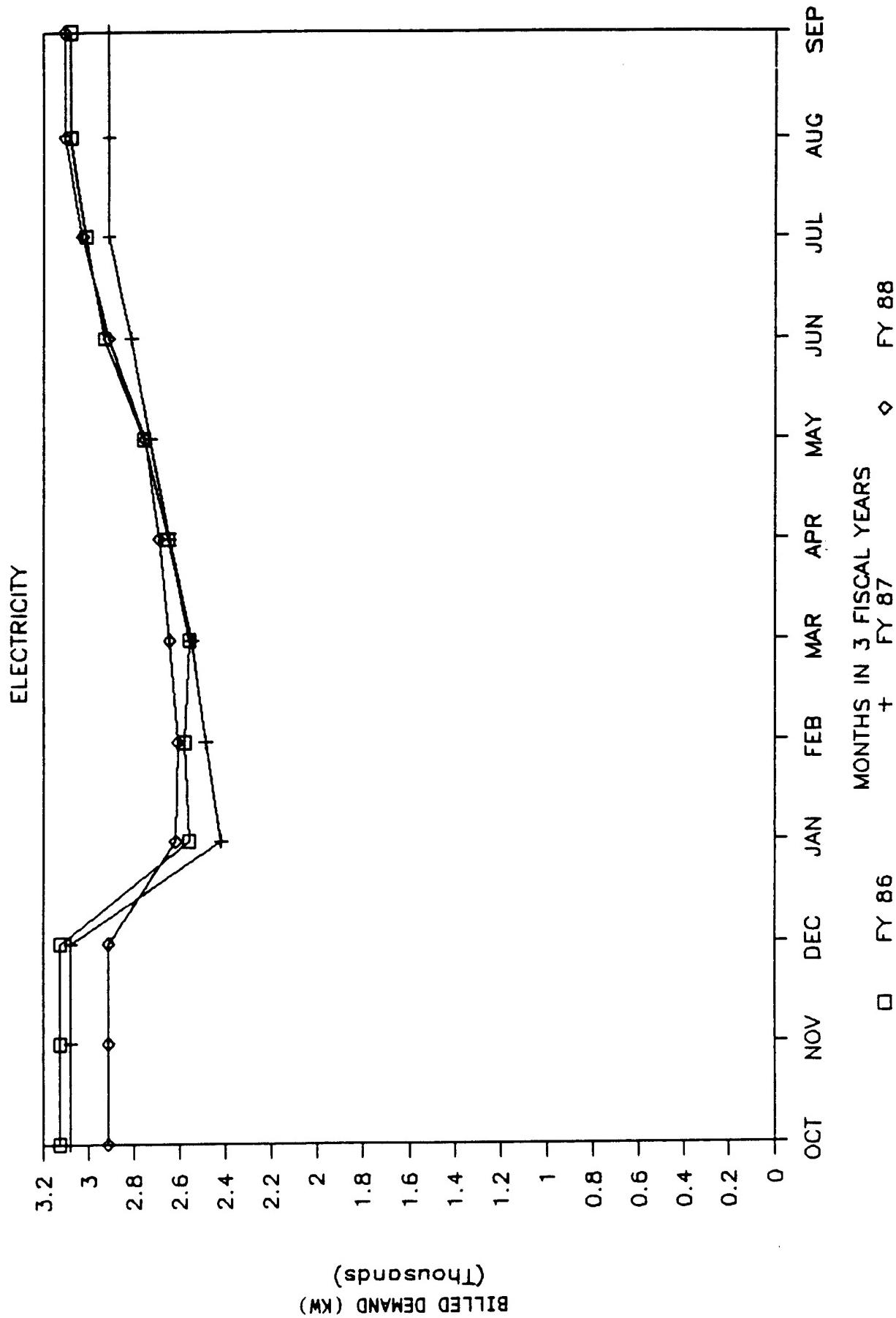


FIGURE 3.5.1

GRUENSTADT UTILITY HISTORY

BOILER PLANT NATURAL GAS

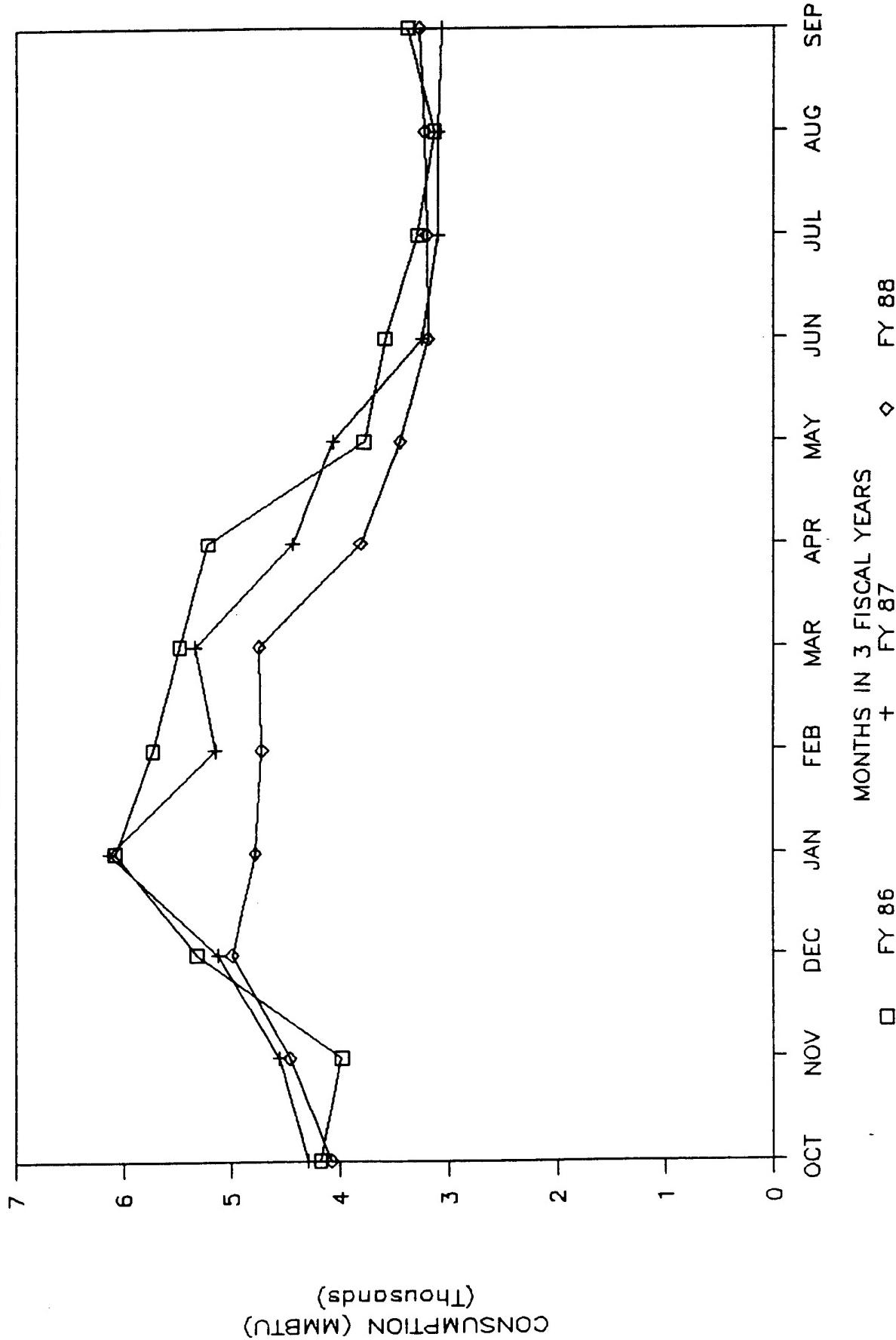


FIGURE 3.5.2 GRUENSTADT UTILITY HISTORY

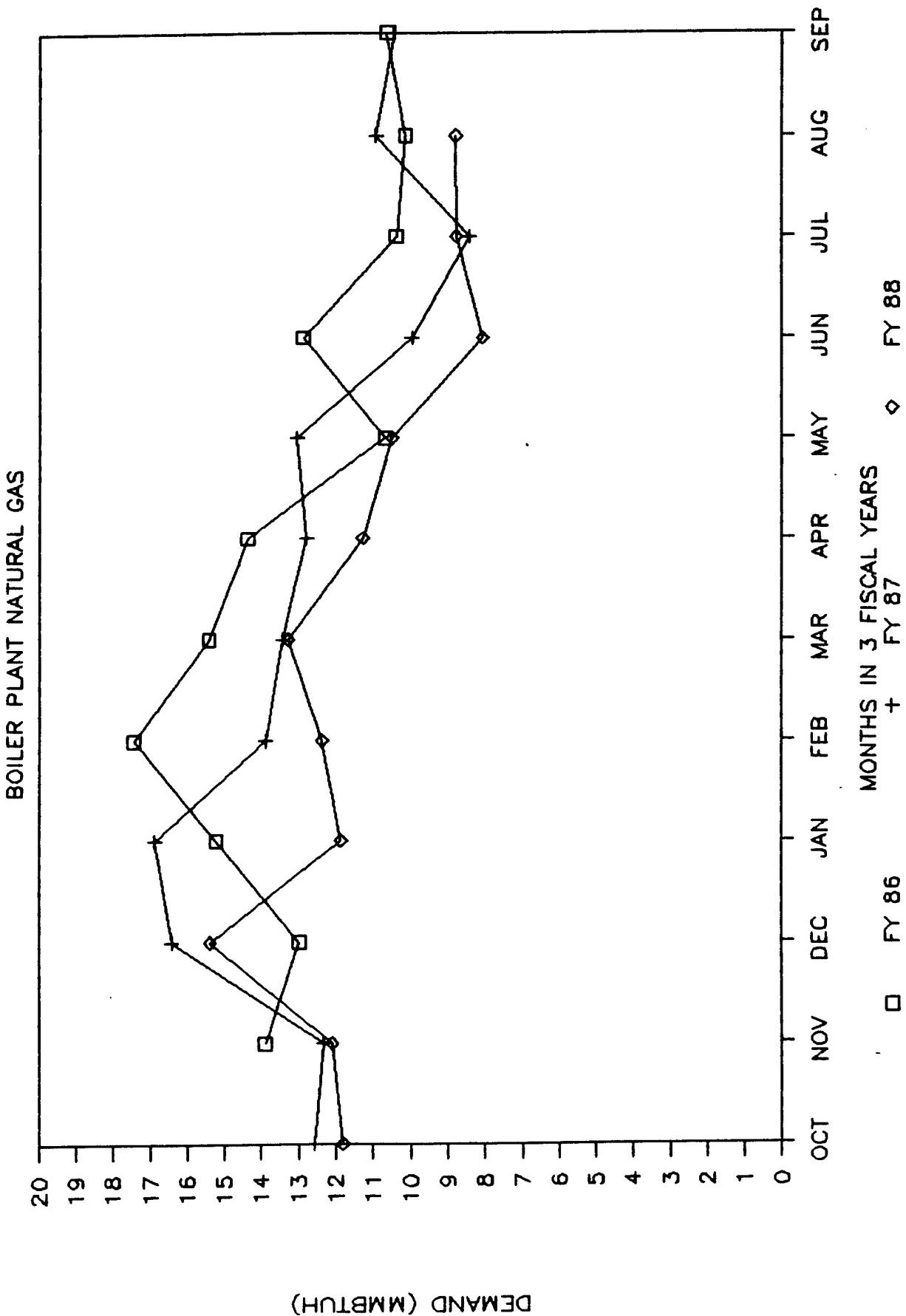


FIGURE 3.6.1

GRUENSTADT UTILITY HISTORY
BAKERY NATURAL GAS

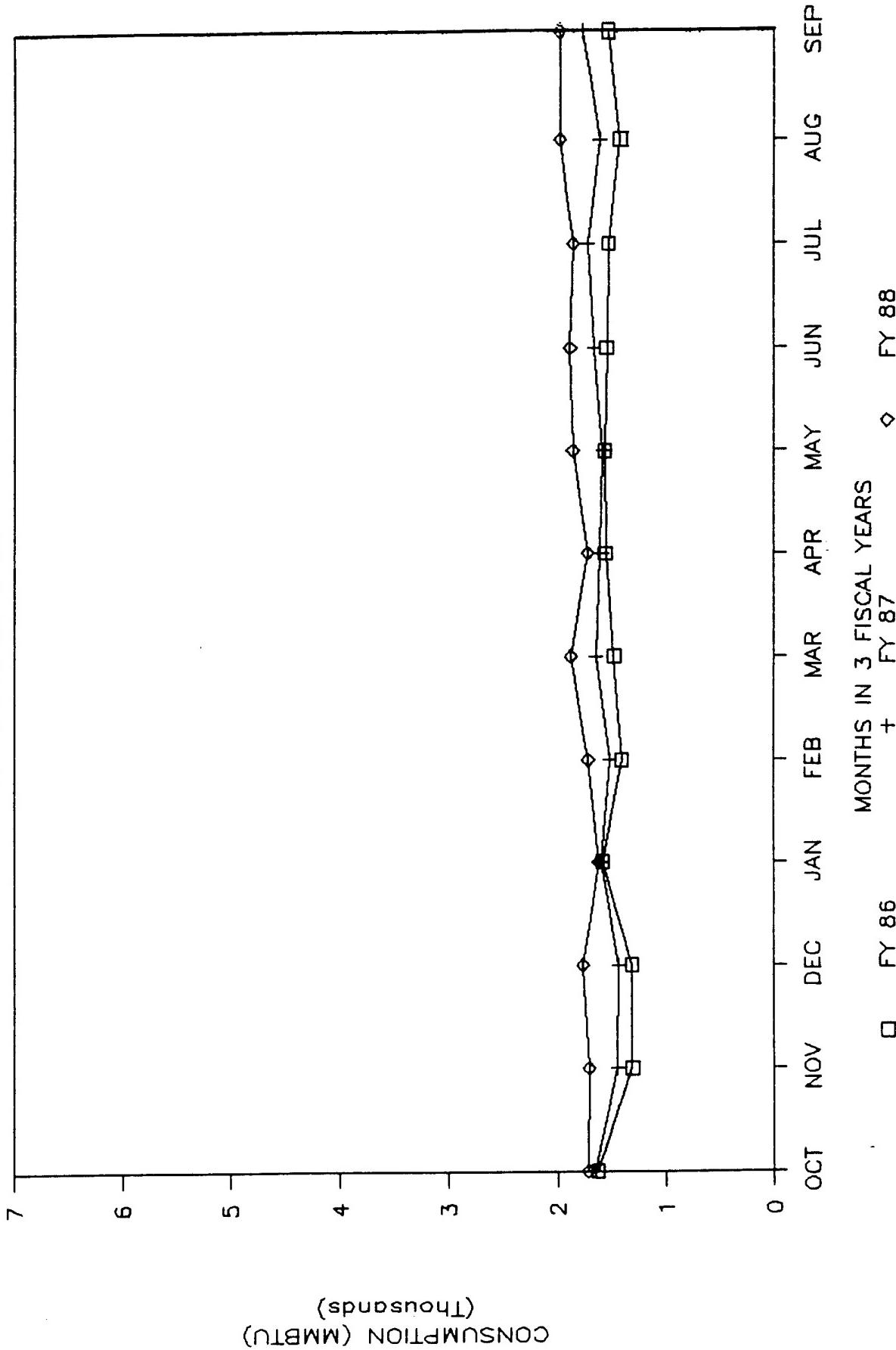


FIGURE 3.6.2 GRUENSTADT UTILITY HISTORY

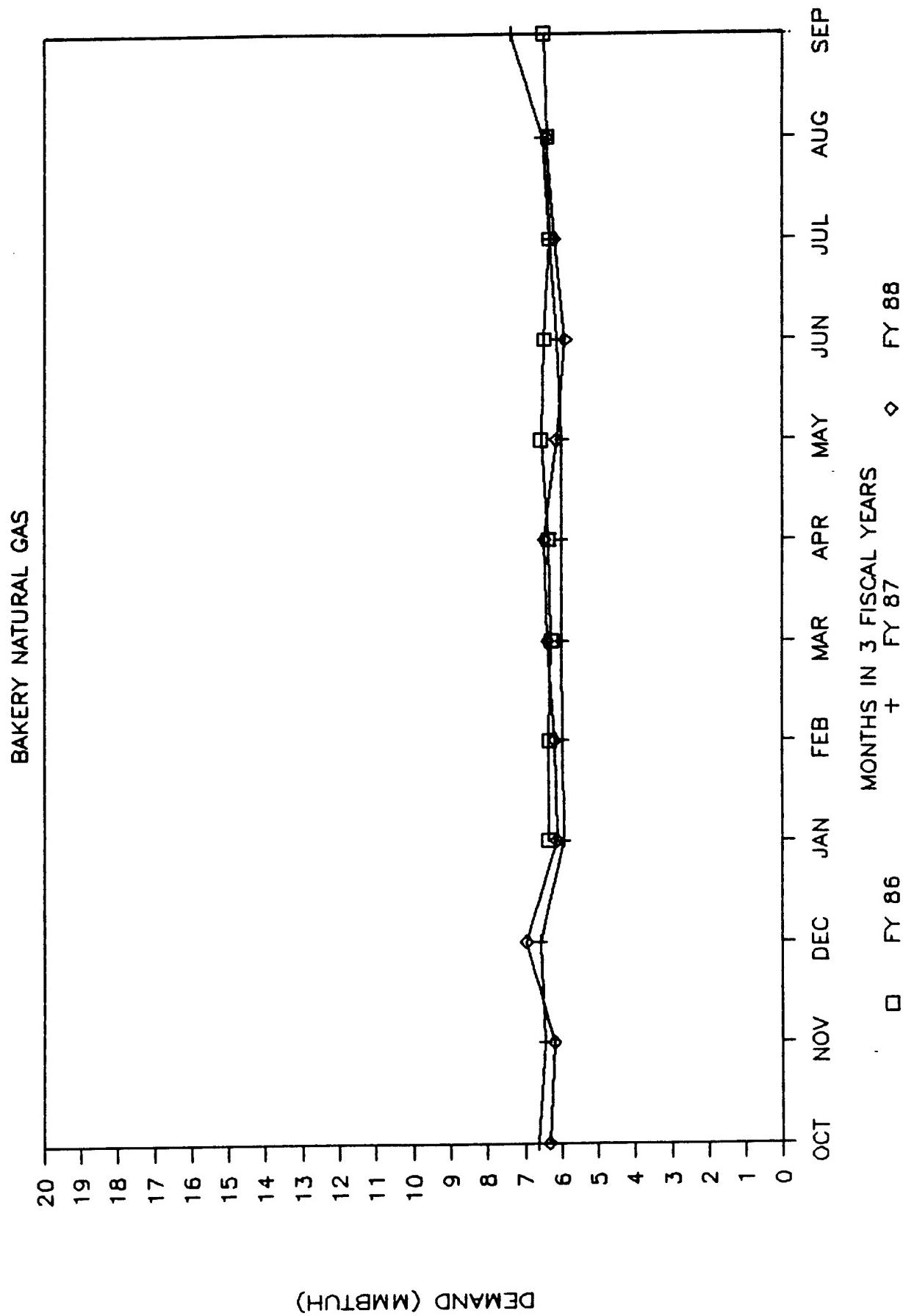


FIGURE 3.7.1 GRUENSTADT UTILITY HISTORY

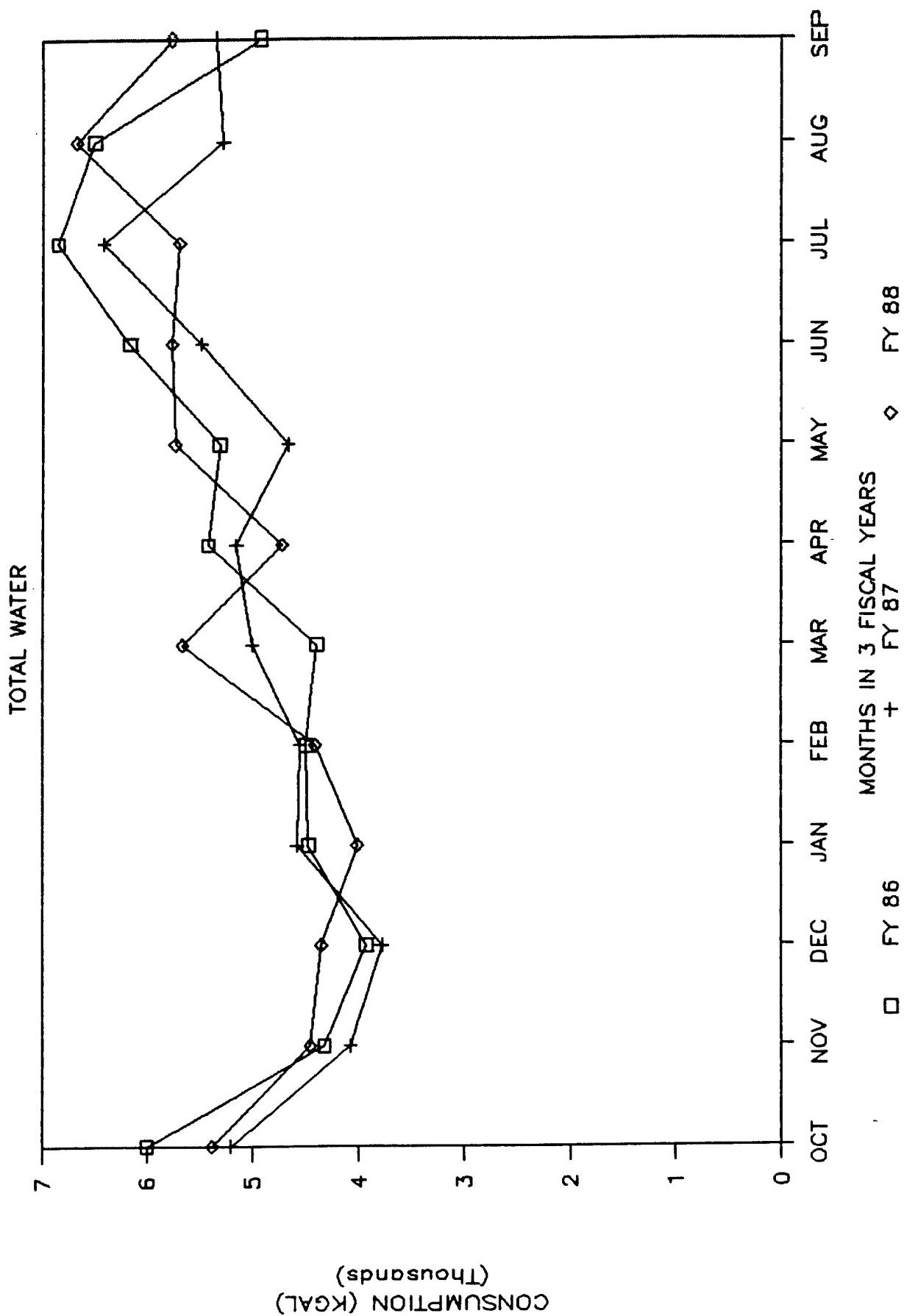


FIGURE 3.8.1 DAILY DEMAND PROFILE
SUBSTATION # 1 (MEASURED)

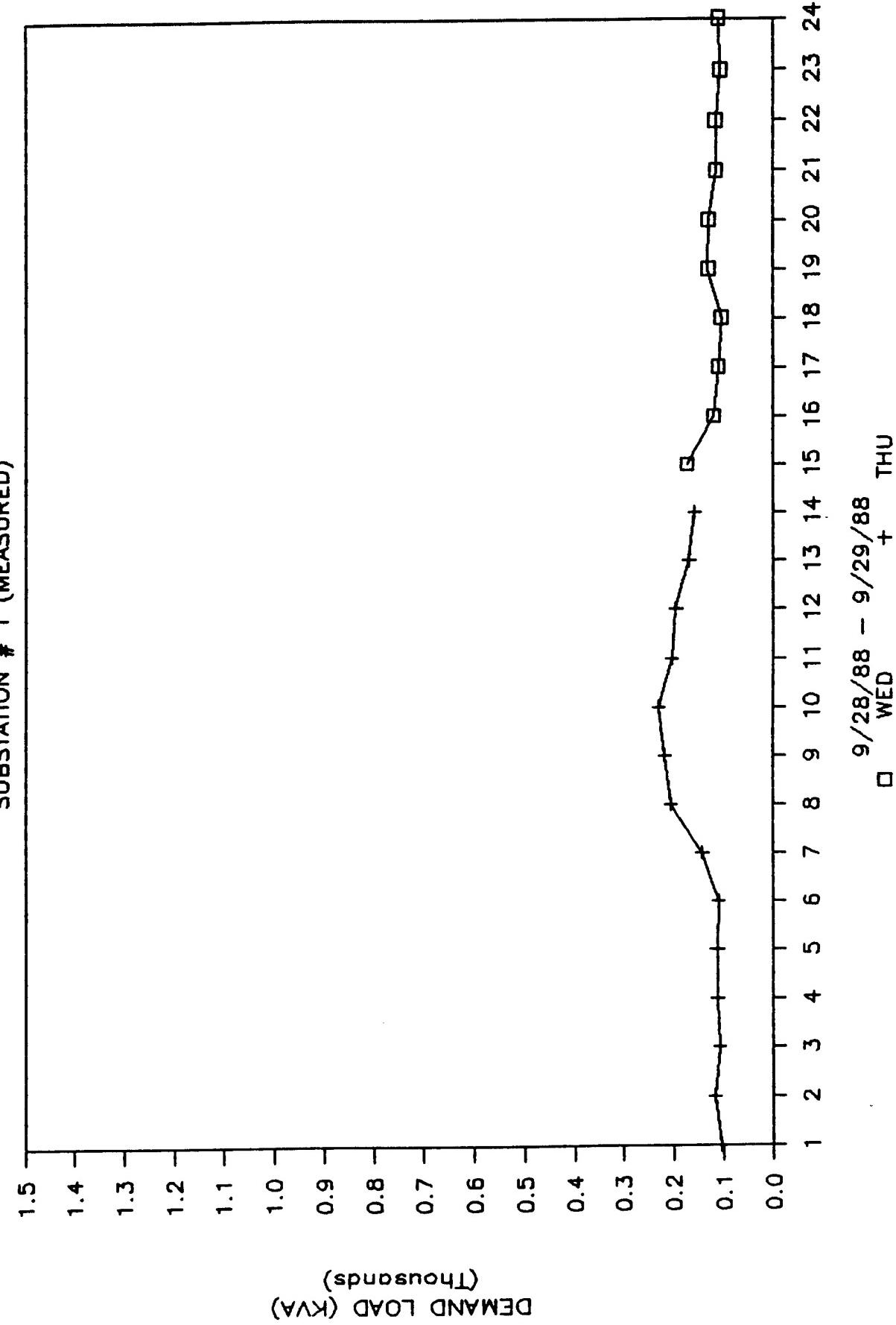


FIGURE 3.8.2 DAILY DEMAND PROFILE
SUBSTATION #2 (MEASURED)

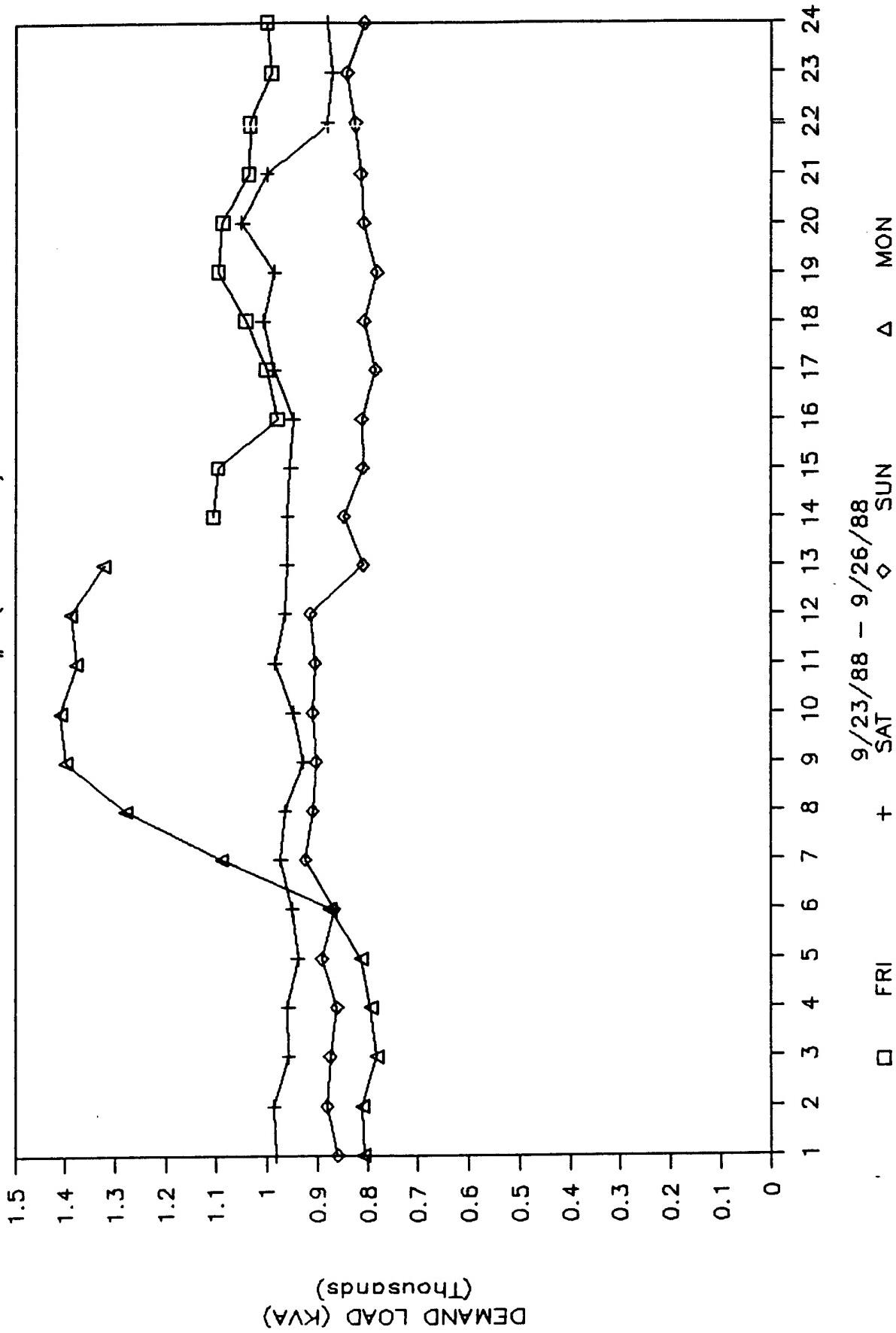


FIGURE 3.8.3

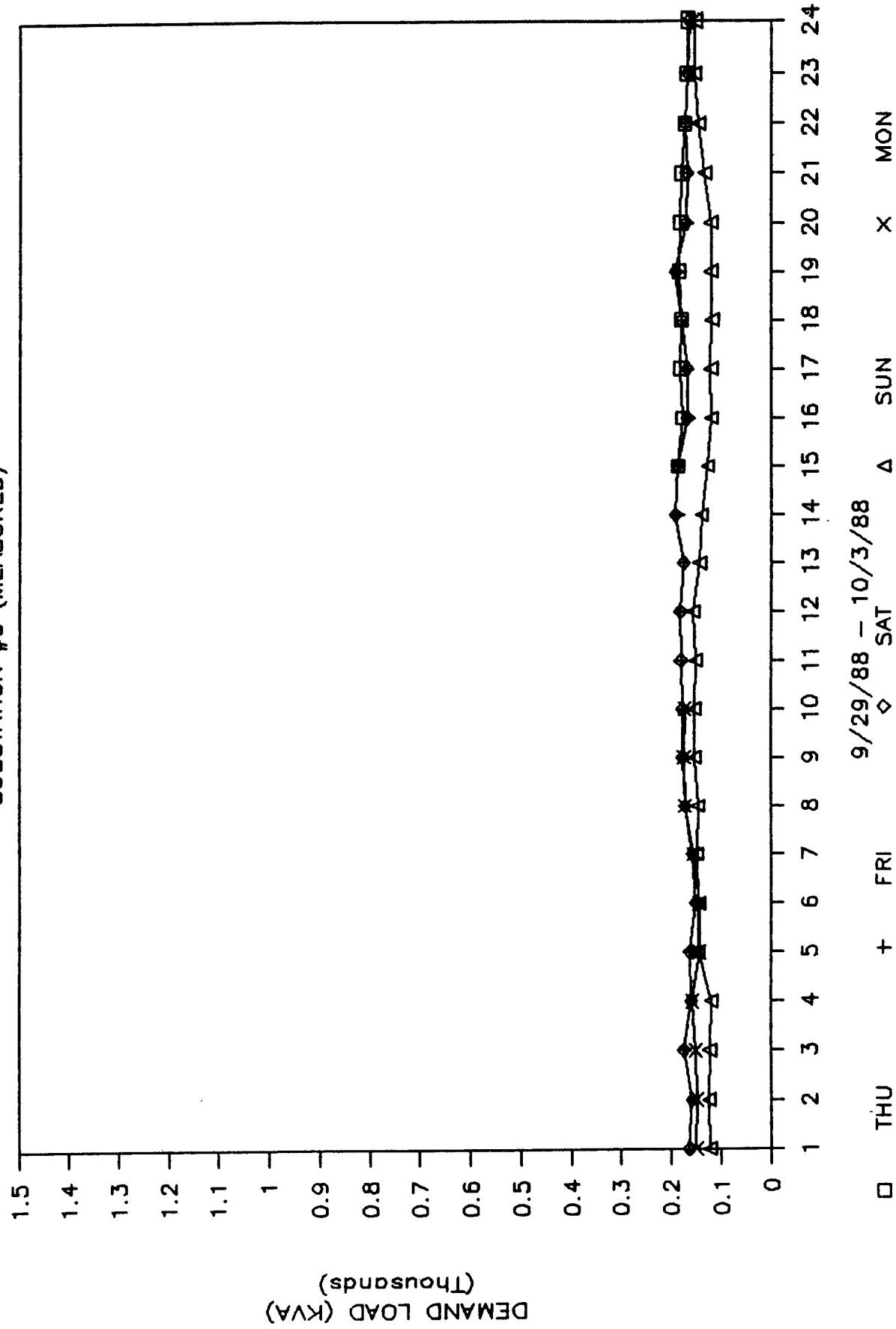
DAILY DEMAND PROFILE
SUBSTATION #3 (MEASURED)

FIGURE 3.8.4 DAILY DEMAND PROFILE
SUBSTATION #4 (MEASURED)

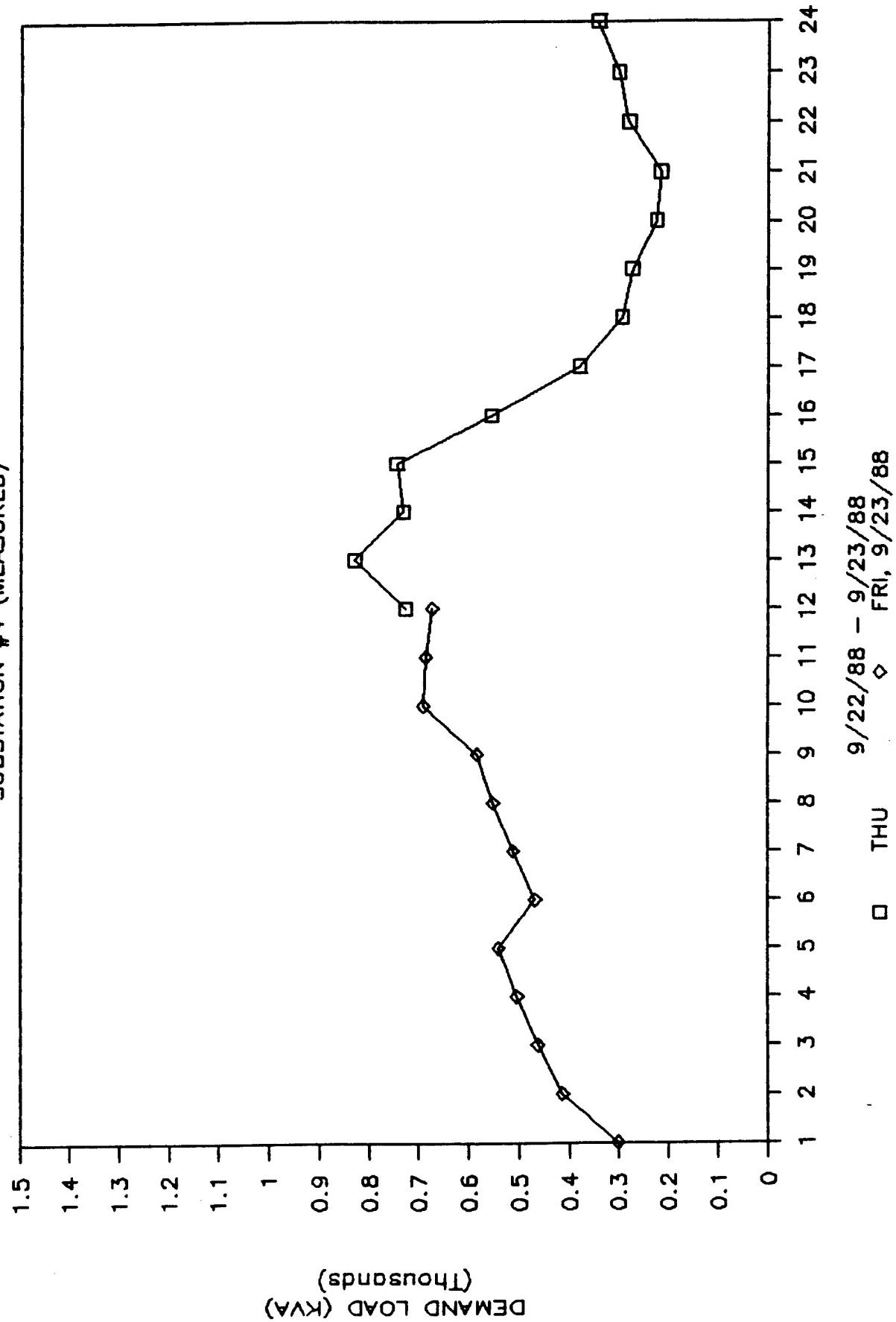
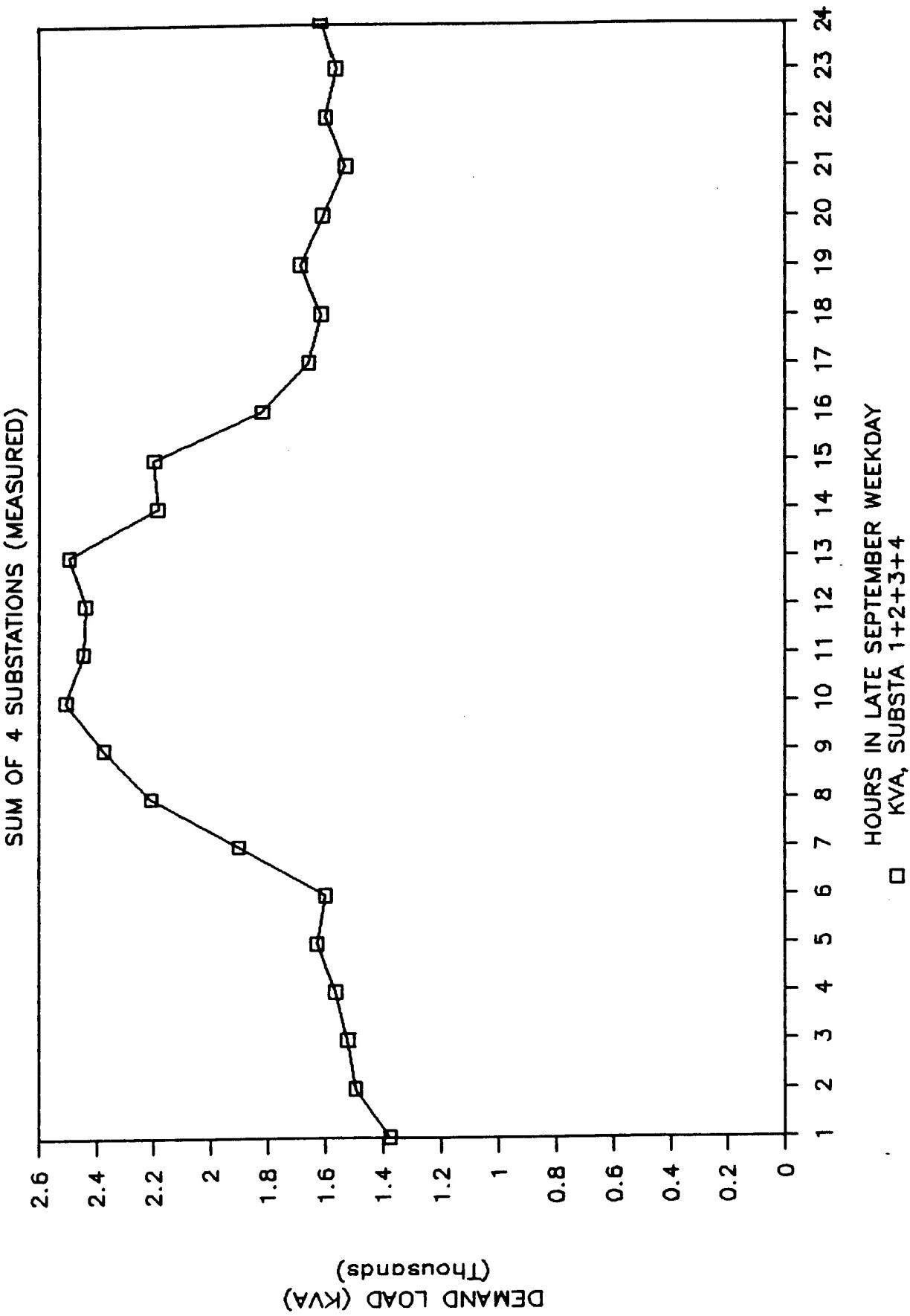


FIGURE 3.8.5 TOTAL DAILY DEMAND PROFILE



SECTION 4

PRESENT ENERGY CONSUMPTION

- 4.1 SECTION OVERVIEW
- 4.2 ANALYSIS OF ANNUAL ENERGY USAGE
- 4.3 MAJOR ENERGY USERS
- 4.4 ANNUAL ENERGY CONSUMPTION PER PRODUCT
- 4.5 ANALYSIS OF ELECTRICAL POWER USAGE
- 4.6 ANALYSIS OF BOILER GAS USAGE
- 4.7 ANALYSIS OF BAKERY GAS USAGE
- 4.8 ANALYSIS OF WATER USAGE

4.1 SECTION OVERVIEW

The purpose of this section is as follows:

- o Analyze the energy and utility consumption for the facility
- o Determine trends in energy consumption
- o Determine magnitudes of energy usage for major systems
- o Establish the maximum reasonable cost savings which can be realized due to implementation of energy conservation opportunities.

Refer to Section 3 of the Executive Summary for presentation of the utility bills for the past 3 years, including electricity, boiler natural gas, bakery natural gas, and water.

Tables, charts, and graphs are located at the end of this Section. Data from utility bills, the DOE 2.1c computer simulation of energy usage, and field measured data were used to prepare the following pie charts, graphs, and bar charts for analysis:

- o Pie chart showing portion of annual energy consumption for electricity, boiler natural gas, and bakery natural gas.
- o Pie chart showing portion of annual costs for electricity, natural gas, and water consumption.
- o Pie chart showing breakdown of energy consumption by major user.
- o Pie chart showing breakdown of energy costs by major user.
- o Bar graph showing energy consumption per end product.

4.2 ANALYSIS OF ANNUAL ENERGY USAGE

The utilities serving the facility include electricity, natural gas and water. Each of these utilities is metered separately.

Electricity is metered at one point. Monthly electric utility bills are based on charges for peak demand, on-peak consumption and off-peak consumption.

Natural gas is metered at two points within the depot. One gas meter measures demand and consumption at the central plant where boilers produce steam for distribution in the facility. The other gas meter measures demand and consumption for the bakery and sweet goods ovens, proofers, and fryers.

Water is metered by the utility company at one point. Water is used for cooling of refrigeration compressors, the ice cream pasteurizing heat exchanger, and evaporative coolers. Water is also used for production, cleaning, and domestic uses.

Table 4.2.1 lists the annual energy consumption and costs for the utilities based upon utility bills for 3 fiscal years FY 86 - FY 88. The annual costs are based upon current energy prices.

The pie chart of Figure 4.2.2 shows the percentages of the total annual energy consumption for bakery natural gas, boiler natural gas, and electricity. The pie chart indicates that approximately the same amount of energy is used annually for electrical power and for generation of boiler steam from gas.

The pie chart of Figure 4.2.3 shows the percentages of the total annual utility costs for bakery natural gas, electricity, and water. The pie chart indicates that the annual cost of electrical power is much higher than all other utility costs. This indicates that reducing electrical consumption has a greater impact upon cost savings than reducing gas consumption.

The facility uses a total of 327,000 BTU/SF/YR. This is based upon 124,000 MMBTU's of site electricity and natural gas energy usage for FY 88, for 378,837 facility square feet. It is not uncommon for food processing and cold storage facilities to use over 2 million BTU/SF/YR.

The energy consumption of this facility is substantially more than the 70,000 to 85,000 BTU/SF/YR documented in the Engineering Technical Letter 86-1, dated April 1, 1986, for industrial or cold storage areas for region 2 overseas. The facility uses more energy than the Energy Budget Figure (EBF) for some of the following reasons:

1. The EBF is useful to establish out-of-range energy consumption values of existing facilities, only when energy is used primarily for human comfort. The existing facility includes a bakery, ice cream plant, meat processing, and cold storage which are primarily process loads. Therefore, the EBF should not be used to determine the target energy consumption of this industrial facility.

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is shared by
the reviewer →

By definition, Energy Budget Figures may not include process loads. Perhaps if these were subtracted from the total, the remainder would be within the target for the region.

2. Bakery production is essentially a 24 hour operation, from product mixing to equipment cleaning, rather than 8 hours per day.
3. On site auxiliaries such as exterior lighting and truck cleaning are included in the calculated facility energy usage.
4. Cold storage areas operate 24 hours per day, 365 days per year. The EBF's do not account for continuous usage in a food production and refrigeration facility.
5. Cold storage areas are maintained at temperatures from 50°F to -40°F . The EBF's do not indicate temperature ranges of warehouse storage facilities.

4.3 MAJOR ENERGY USERS

Results of the Baserun computer simulation were used to determine the breakdown of annual energy consumption of the major users. The energy usage of the major users of energy at the facility are listed in Table 4.2.1, and are defined as follows:

- REFRIGERATION: Electrical power requirements for cold storage equipment, including compressors, pumps, fans, evaporative coolers, etc.
- HVAC FAN AUX: Electrical power for HVAC equipment used for environmental heating and cooling for human comfort, in administration and production areas. Included are air handling unit fans, heating water pumps, steam condensate pumps, etc.
- LIGHTING: Electrical power for interior lighting in all spaces.
- EQUIP PROCESS: Electrical power for production equipment, battery chargers, and miscellaneous process loads.
- SPACE HEATING: Gas for steam for heating of all spaces.
- DOMESTIC HW: Gas for steam heating of domestic water for purposes of cleaning, handwashing, and showers.
- STEAM PROCESS: Gas for steam used in processes in bakery and ice cream plant.
- BAKERY GAS PROCESS: Gas used directly by bakery production equipment such as ovens, proofers, and fryers.

OTHER FACIL. ELECT: Electrical power for other buildings on site, not included in this study.

OTHER FACIL. GAS: Gas for steam for other buildings on site, not included in this study.

Table 4.2.1 lists the annual energy consumption and costs for the major energy users.

The pie charts of Figures 4.3.1 and 4.3.2 show relative quantities of energy consumption (MMBTU/YR) and costs (\$/YR) for each major user.

Figure 4.3.1 indicates that the two largest users of energy (MMBTU/YR) are steam for bakery production equipment (25.4%) and refrigeration equipment electrical power (18.6%). There is more potential for energy savings with the refrigeration equipment than with processes. This is primarily due to limitations posed by food production regulations to maintain product temperatures, such as sterilization, humidity control, fermentation, prevention of staling, freezing, and proper operation of meat processing equipment.

Figure 4.3.2 shows that the two areas of largest energy costs are refrigeration electrical power (35.5%), and process equipment electrical power (14.1%). Although steam for bakery production equipment is the largest energy user, it represents only 10.3% of the total utility costs. This is because the cost of electrical energy is approximately five times the cost of natural gas per BTU. The task of reducing operating costs is therefore related but not directly proportional to energy savings.

4.4 ANNUAL ENERGY CONSUMPTION PER PRODUCT

The bar graphs of Figures 4.4.1 and 4.4.2 show energy consumption of bakery production, ice cream production, and meat processing in pounds per year and BTU/END PRODUCT/YR. Values are based upon 41.9 million pounds of baked goods produced per year, 2.88 million gallons of ice cream produced per year, and 5.09 million pounds of meat processed per year. Calculations indicate the site energy consumption to be 1970 BTU/lb baked goods, 800 BTU/lb ice cream, and 1340 BTU/lb meat.

4.5 ANALYSIS OF ELECTRICAL POWER USAGE

The graph of Figure 4.5.1 indicates the total site electrical demand in KW each hour, as field measured during the data gathering survey. Hourly electrical demand was measured and recorded at the four transformer substations of the facility. Refer to Section 9 of the Data Gathering Report for field measured hourly KVA for each of 4 transformer substations. Hourly measurements were then summed together to determine the combined demand for all buildings. The resulting demand curve for a typical late September day is found in Figure 4.5.1

The graph shows that between the hours of 7:00 a.m. and 3:00 p.m., the peak load for the facility increases by approximately 900 KVA. This increase is due to refrigeration equipment, administration personnel and associated loads, and peak production of bakery, ice cream, and meat processing equipment. The total facility electrical demand should follow the same general shape of this graph on production weekdays throughout the year. Maximum demand will vary but the hours of the peak, driven by normal production schedules, will not differ appreciably. Weekend demand should approximate the minimum weekday demand.

The graph of Figure 4.5.1 shows a peak of 2300 KW, using .9 power factor. The average peak KW for the month of September, per FY 86 and FY 87 utility bills, is approximately 3000 KW. The actual field measured KW is 700 KW less than the billed KW. The additional KW is due to additional ammonia refrigeration during hotter and more humid days, and increased production equipment loads.

The electrical power usage is lower in the winter than in the summer, primarily due to less refrigeration requirements. The graphs of Figures 4.5.2 and 4.5.3 show the KW demand of the central ammonia refrigeration system serving Building 3555, during the summer and during the winter, respectively. The graphs indicate 300 KW less demand in the winter than in the summer. These graphs were obtained from load data extracted from the DOE 2.1c computer simulation program. Other electrical loads which are reduced during the winter months include Building 3559 refrigeration, truck plug-in refrigeration, and ice cream production.

4.6 ANALYSIS OF BOILER GAS USAGE

The graphs of Figures 4.6.1 and 4.6.2 indicate large swings in the steam production over a 24 hour period in January and July of 1988, respectively. The data for the steam graphs were obtained from strip chart recorders in the boiler plant during the data gathering survey. The gas demand to the boilers is directly proportional to the steam usage. These graphs also indicate the need for improved control of steam systems, to reduce gas demand charges.

4.7 ANALYSIS OF BAKERY GAS USAGE

The graphs of Figure 4.7.1 and 4.7.2 show the bakery process gas consumption and demand on a monthly basis. The gas is used for production equipment in the bakery and sweet goods areas. The curves appear independent of weather conditions. Flat curves indicate steady production levels throughout the year, and very little diversity with gas among production equipment. The level curves indicate little potential for gas demand savings.

4.8 ANALYSIS OF WATER USAGE

The graph of Figure 4.8.1 indicates the monthly water consumption.

Water is used for domestic purposes, ice cream heat exchanger cooling, refrigeration compressor cooling, and evaporative cooler make-up. The curves suggest that water usage during the winter months is due to relatively constant ice cream heat exchanger cooling, refrigeration compressor cooling, and evaporative cooler make-up. During the summer months, usage increases for evaporative coolers to maintain low sump temperatures as outdoor air wet bulb temperature increases.

TABLE 4.2.1 - PRESENT ANNUAL ENERGY CONSUMPTION

MAJOR USER	ELECTRICAL KWH/YR	BOILER GAS TH/YR	BAKERY GAS TH/YR	MMBTU/YR	\$/MMBTU	\$/YR USAGE
1 REFRIGERATION	6,742,000	-	-	23,010	23.07	530,851
2 HVAC FANS & AUX	1,856,000	-	-	6,335	23.07	146,138
3 LIGHTING	1,741,000	-	-	5,942	23.07	137,083
4 EQUIPMENT PROCESS	2,679,000	-	-	9,143	23.07	210,939
5 OTHER FACIL ELECT	1,928,000	-	-	6,580	23.07	151,807
6 SPACE HEATING	-	111,700	-	11,170	4.25	47,473
7 DOMESTIC HW	-	32,700	-	3,270	4.25	13,898
8 STEAM PROCESS	-	315,200	-	31,520	4.25	133,960
9 OTHER FACIL GAS	-	68,200	-	6,820	4.25	28,985
10 BAKERY GAS	-	-	202,100	20,210	4.56	92,158
11 WATER	-	-	-	-	-	189,100
3 YEAR AVG, FY 86-88	14,946,183	527,816	202,130			
ELECTRIC POWER	14,946,000	-	-	51,011	23.07	1,176,817
BOILER GAS	-	527,800	-	52,780	4.25	224,315
BAKERY GAS	-	-	202,100	20,210	4.56	92,158
WATER	-	-	-	-	-	189,100
FACILITY TOTAL	14,946,000	527,800	202,100	124,001	-	1,682,389

FIGURE 4.2.2. - SITE ENERGY CONSUMPTION

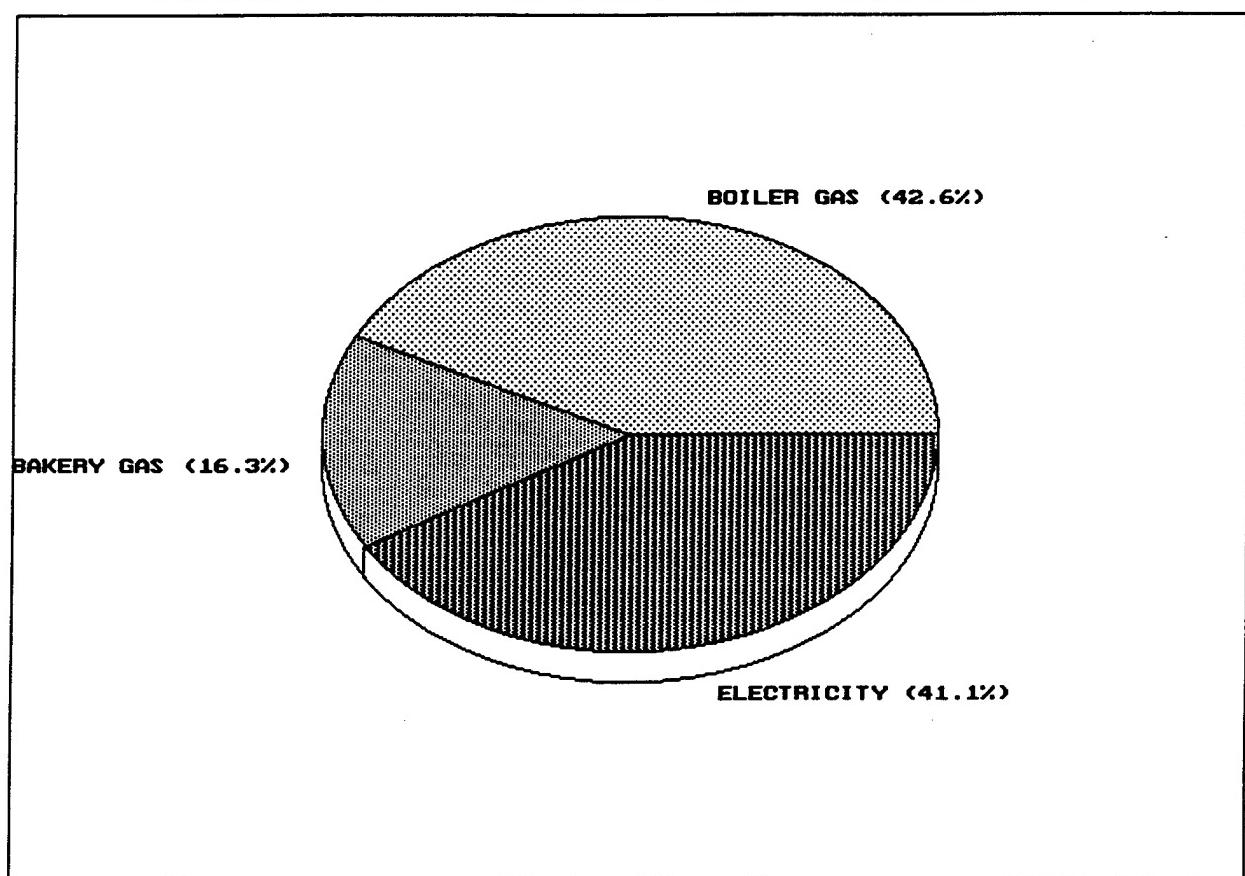


FIGURE 4.2.3 - SITE UTILITY COSTS

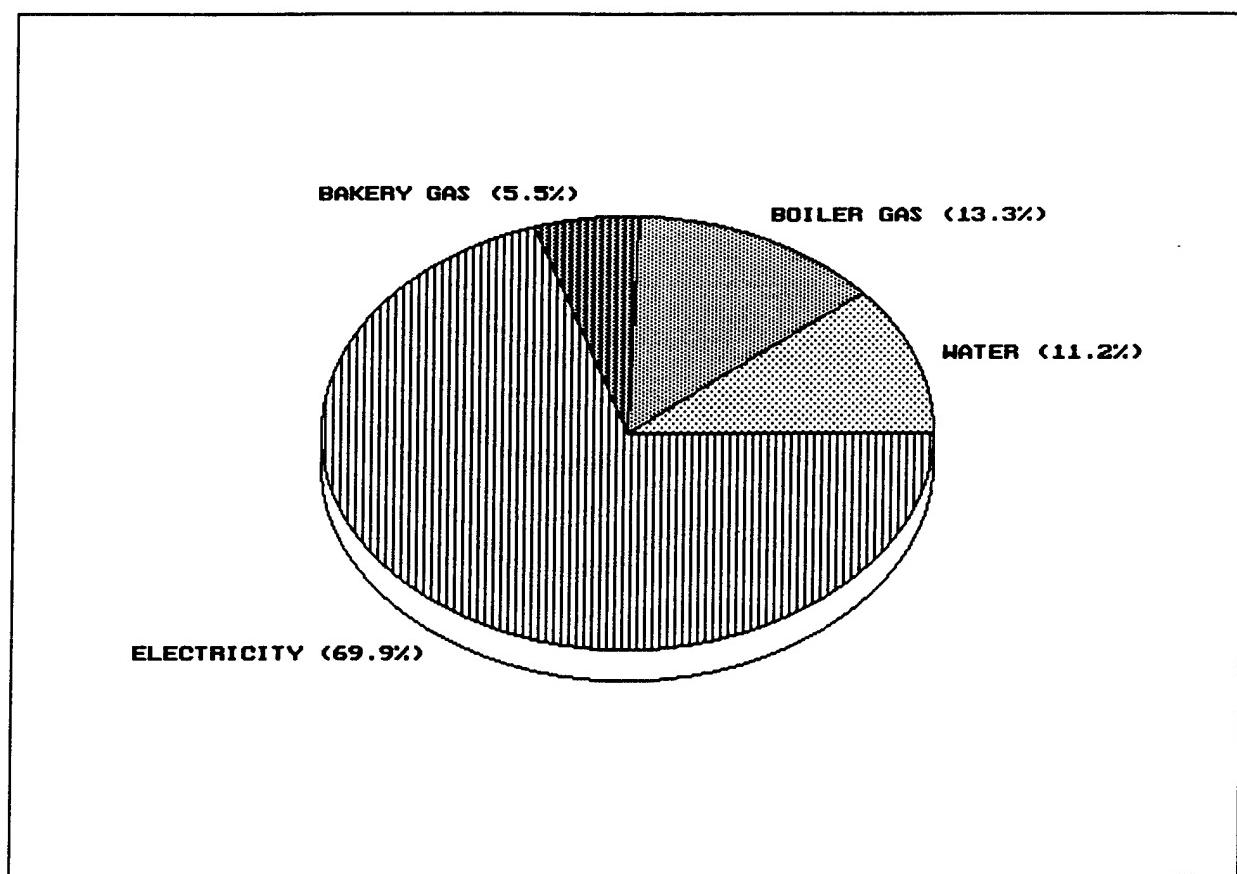


FIGURE 4.3.1 - BREAKDOWN OF ENERGY CONSUMPTION

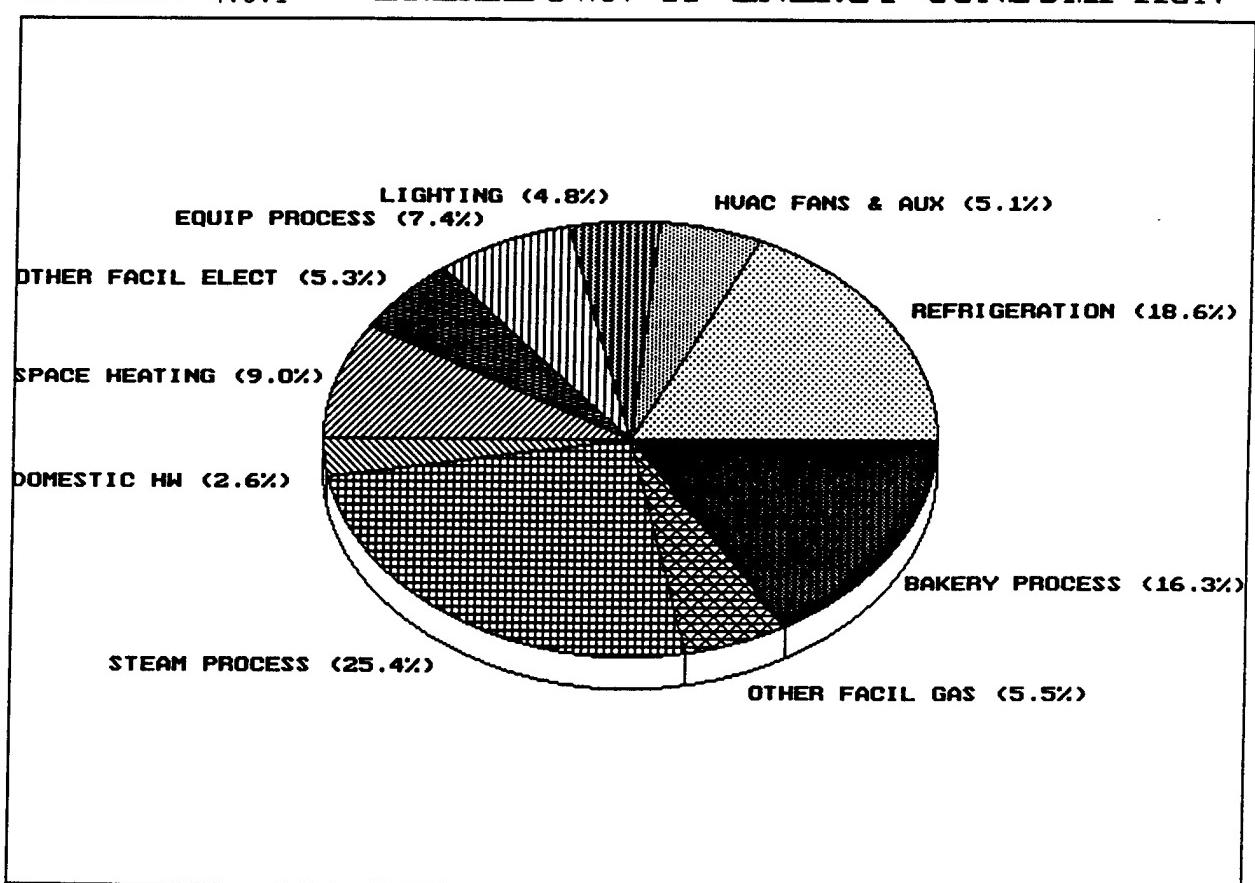


FIGURE 4.3.2. - BREAKDOWN OF ENERGY COSTS

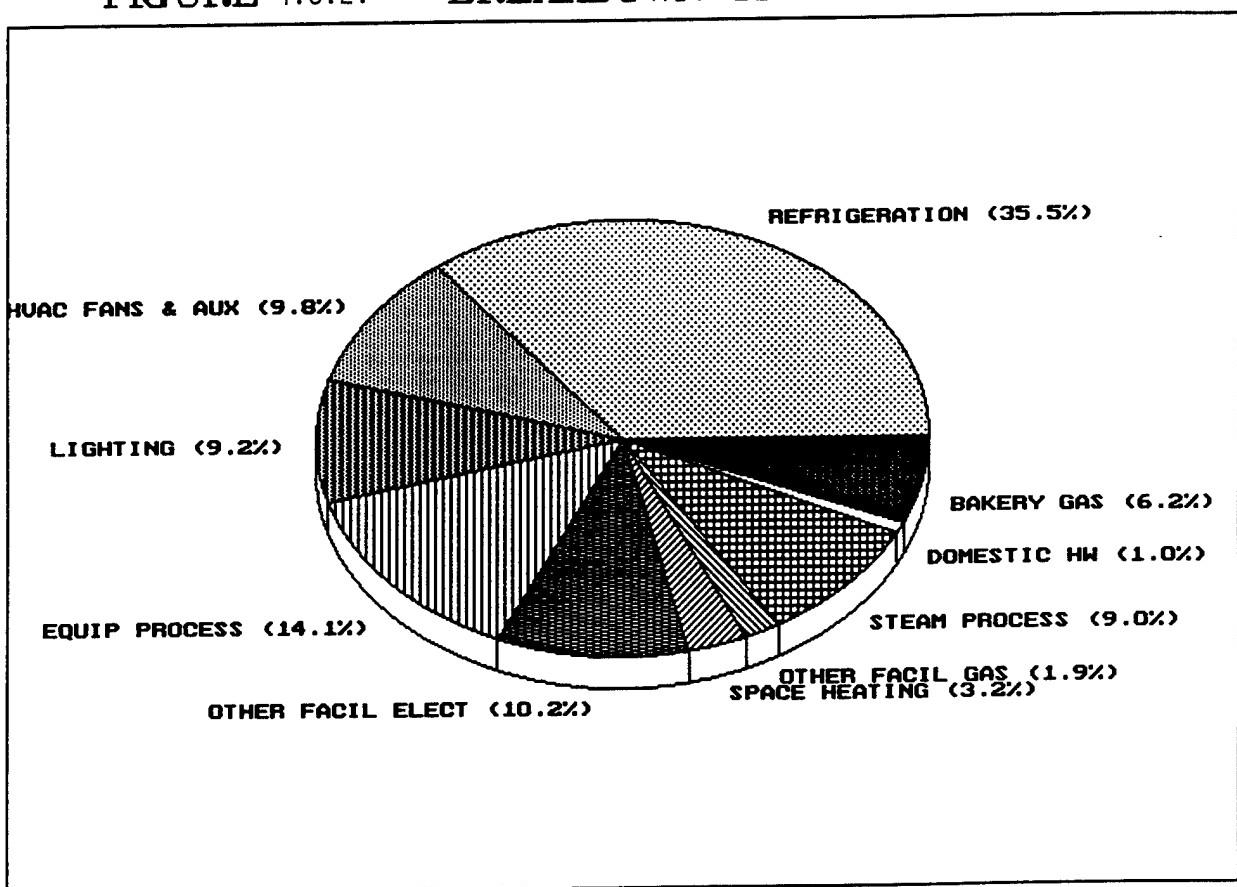


FIGURE 4.4.1 - ANNUAL PRODUCTION LEVELS

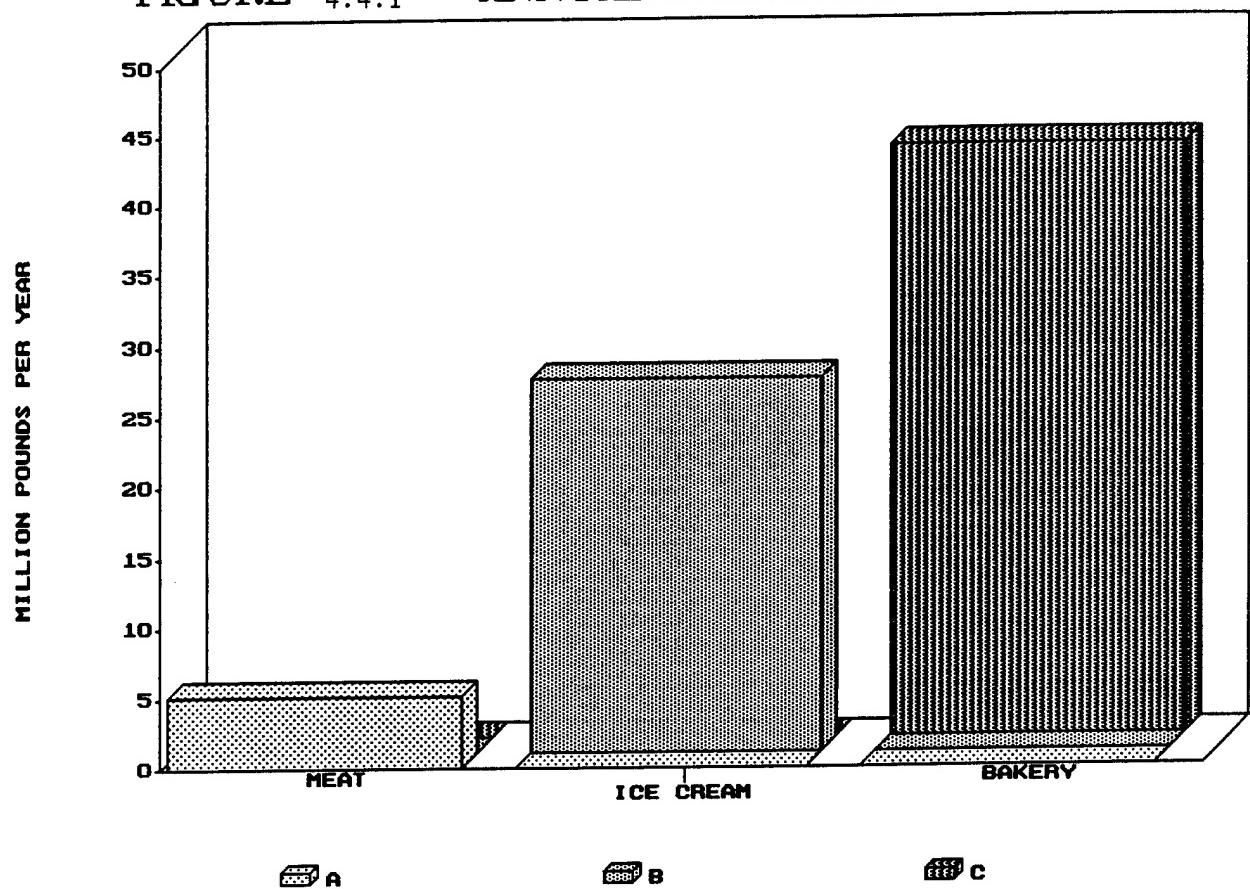


FIGURE 4.4.2 - ENERGY CONSUMPTION PER PRODUCT

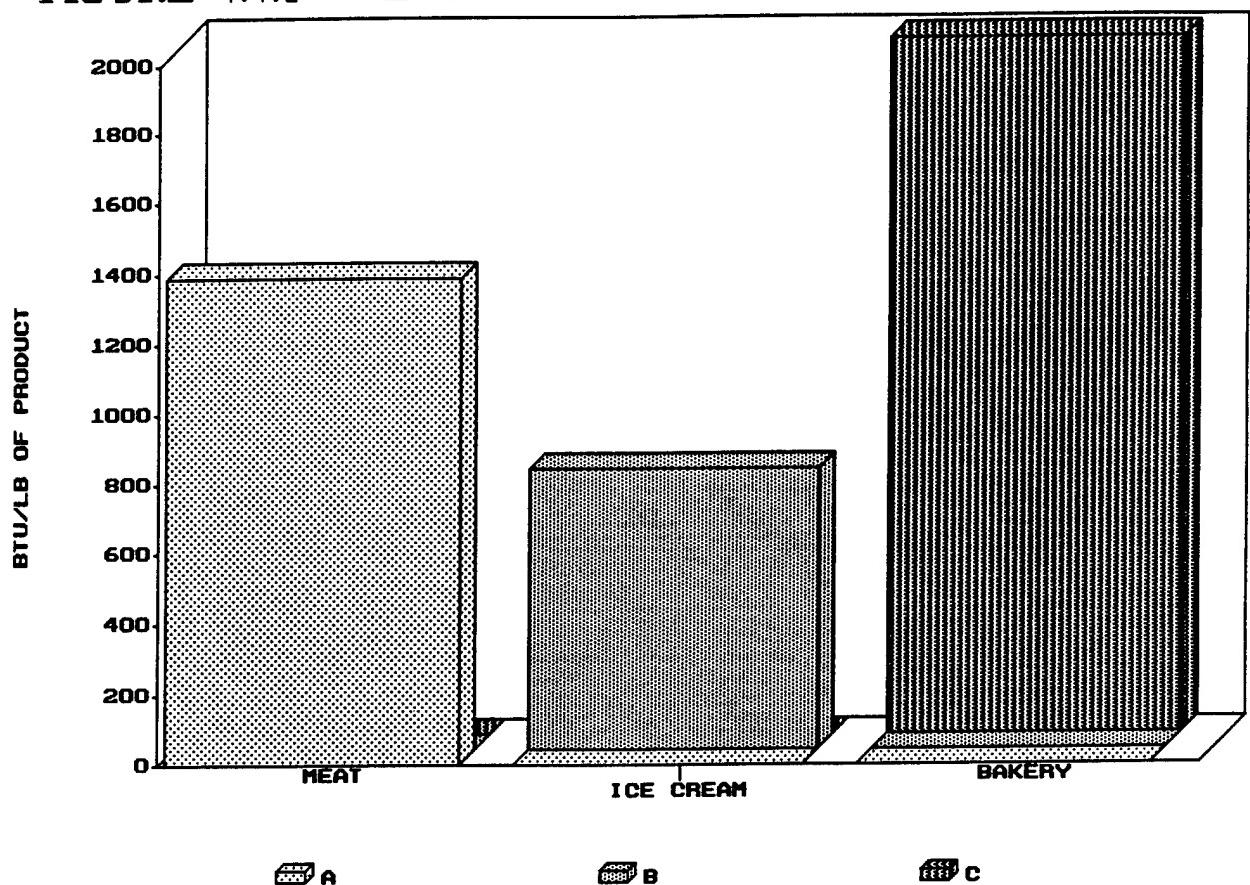


FIGURE 4.5.1

TOTAL DAILY DEMAND PROFILE
SUM OF 4 SUBSTATIONS (MEASURED)

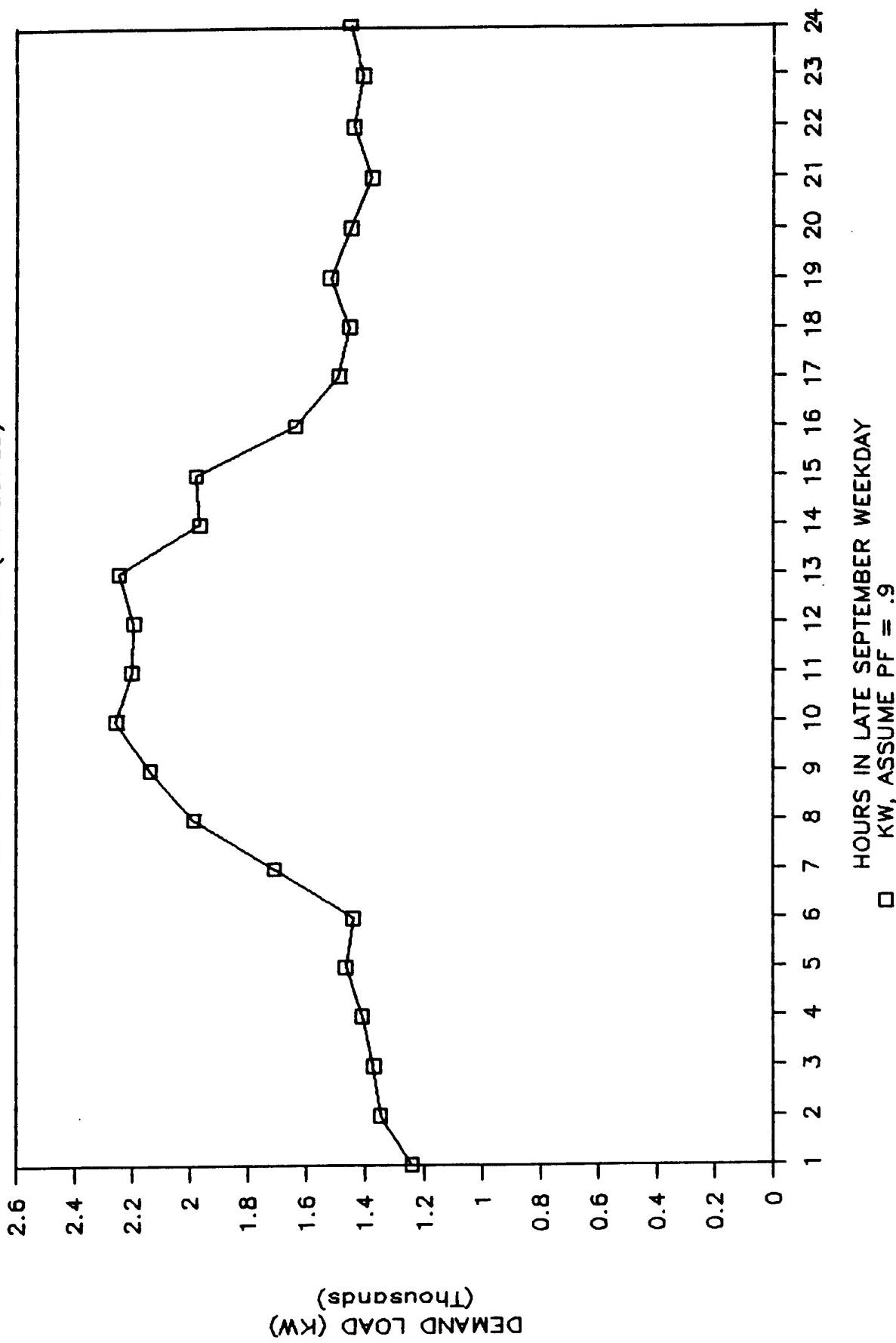


FIGURE 4.5.2 BLDG 3555 CENTRAL REFRIGERATION PLANT

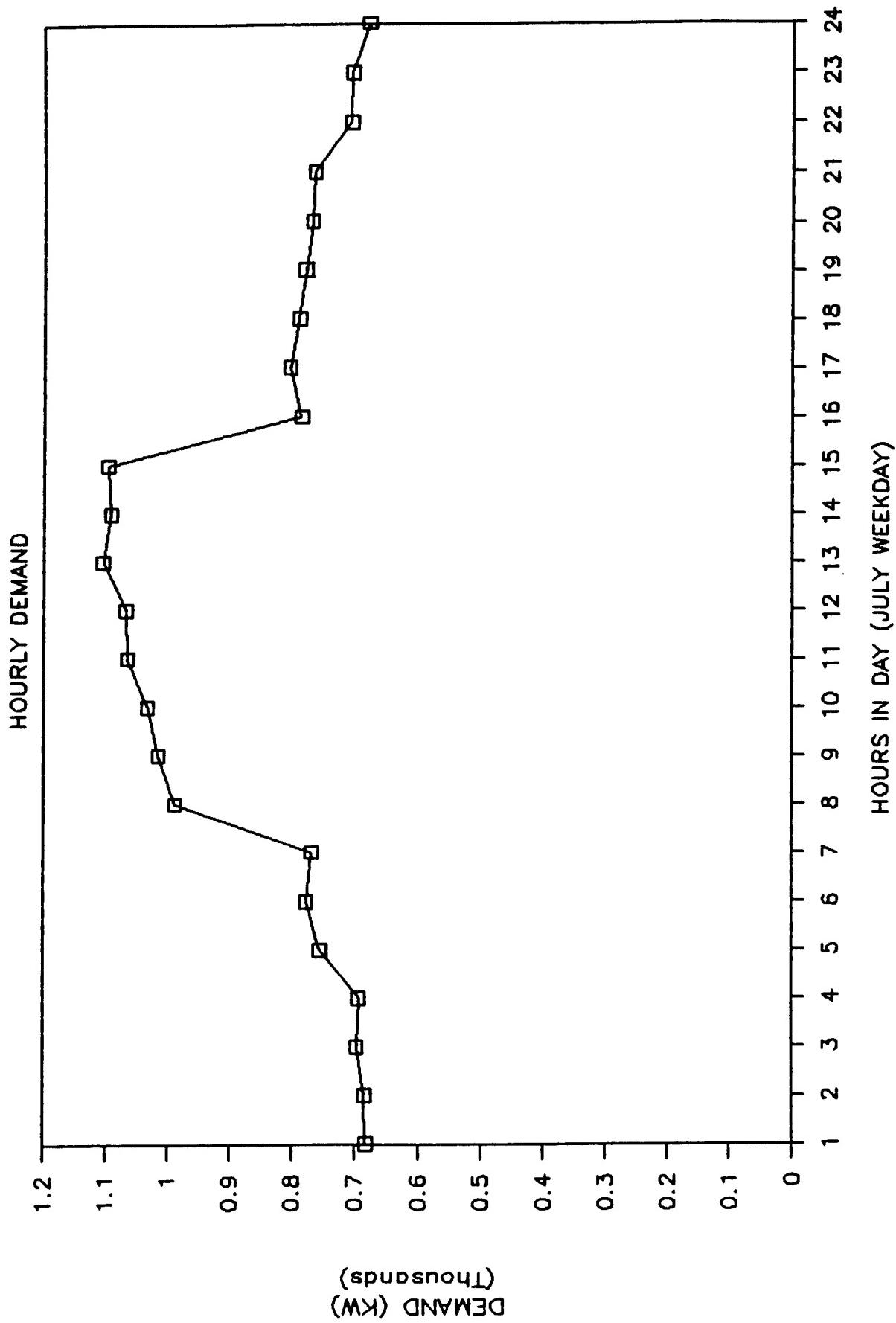


FIGURE 4.5.3 BLDG 3555 CENTRAL REFRIGERATION PLANT

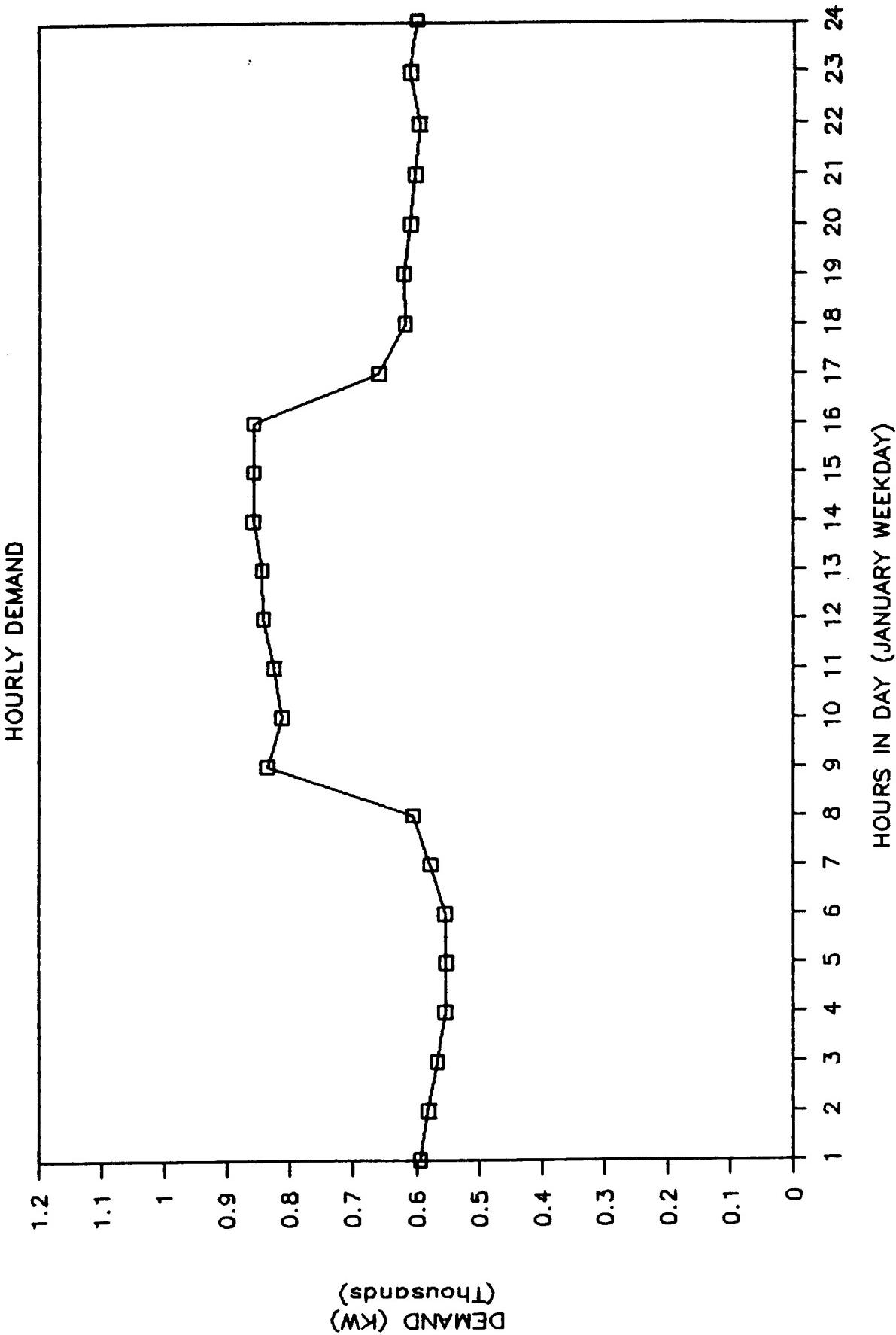
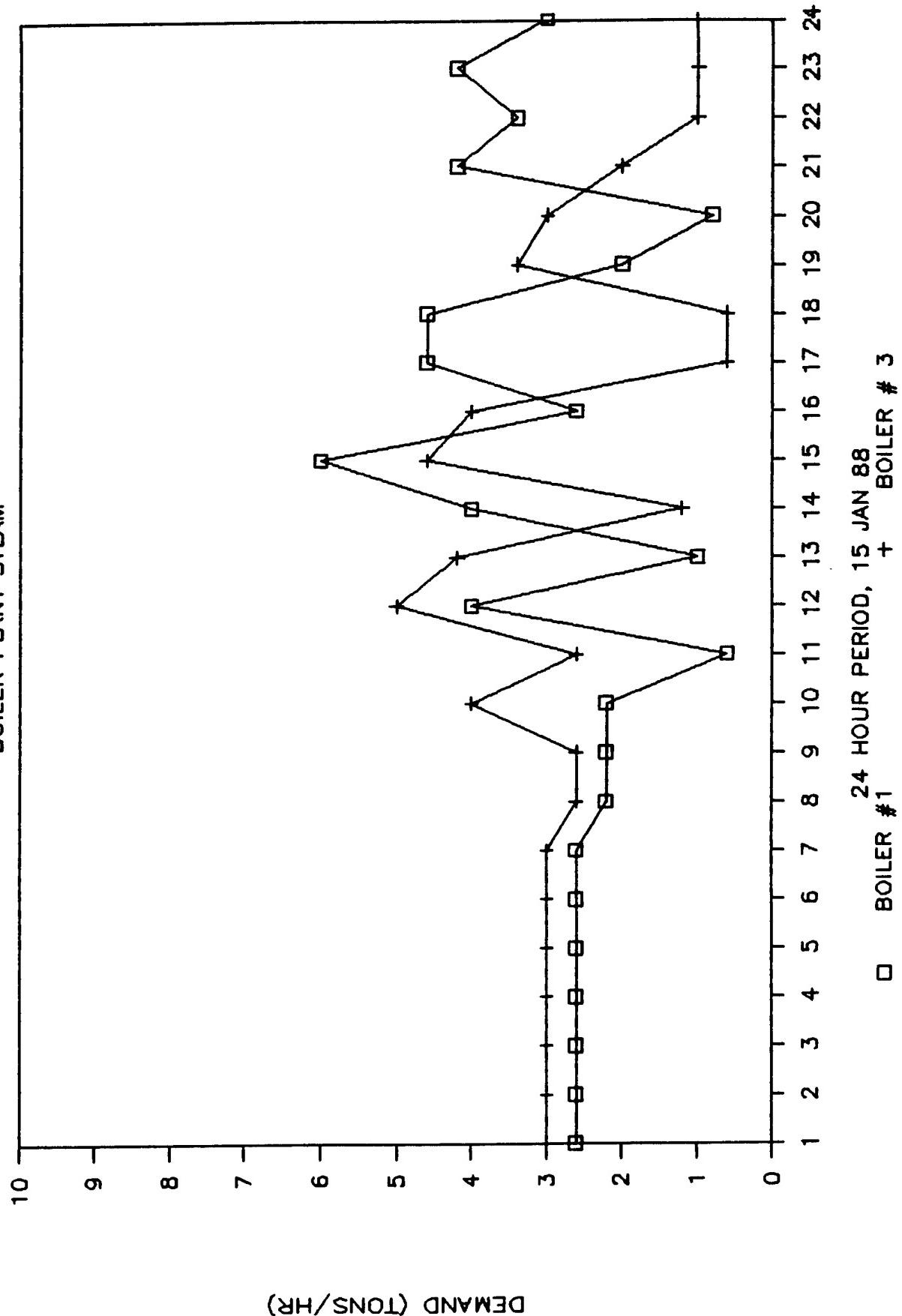


FIGURE 4.6.1 HOURLY DEMAND PROFILE
BOILER PLANT STEAM



DEMAND (TONS/HR)

FIGURE 4.6.2 HOURLY DEMAND PROFILE
BOILER PLANT STEAM

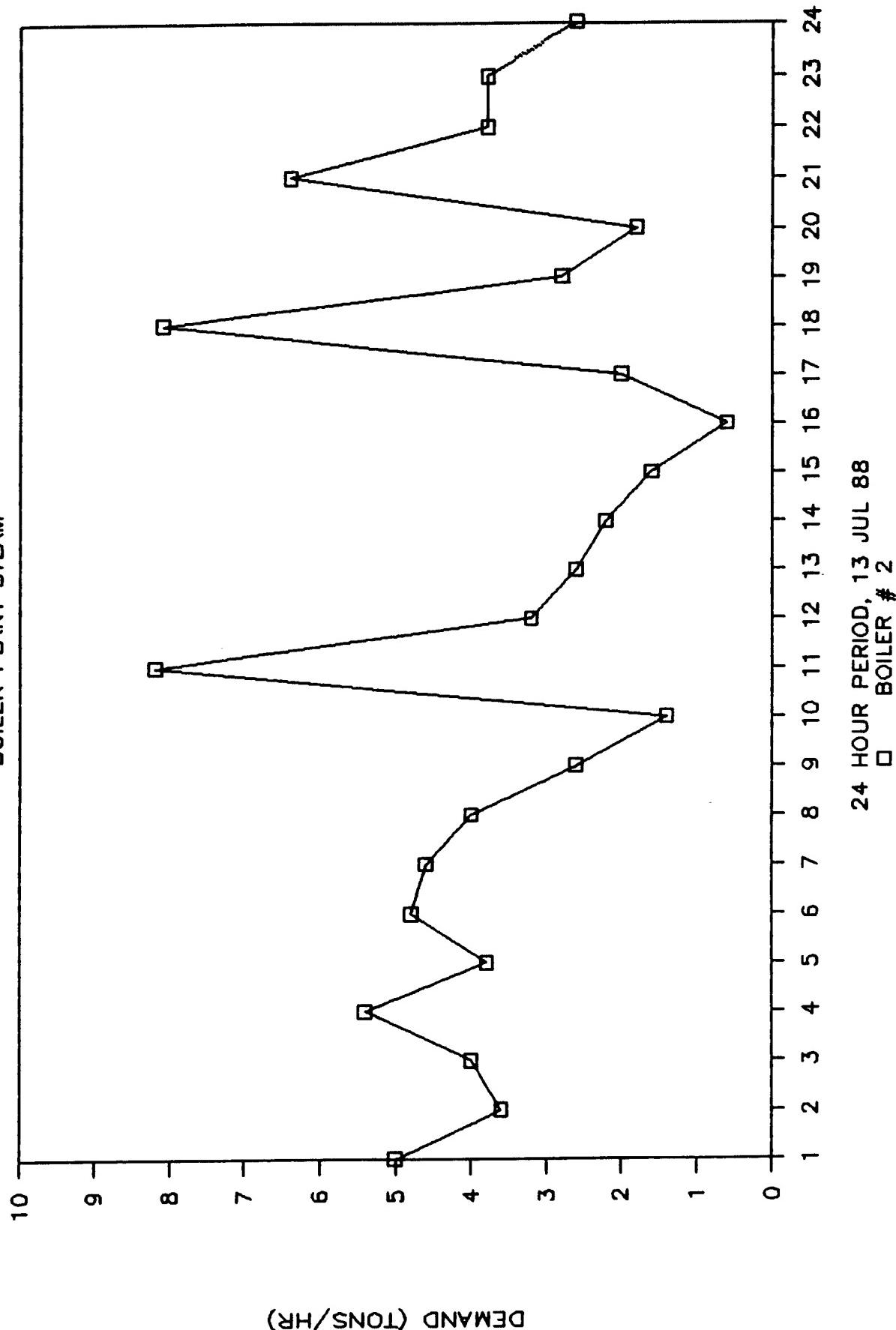


FIGURE 4.7.1 GRUENSTADT UTILITY HISTORY

BAKERY NATURAL GAS

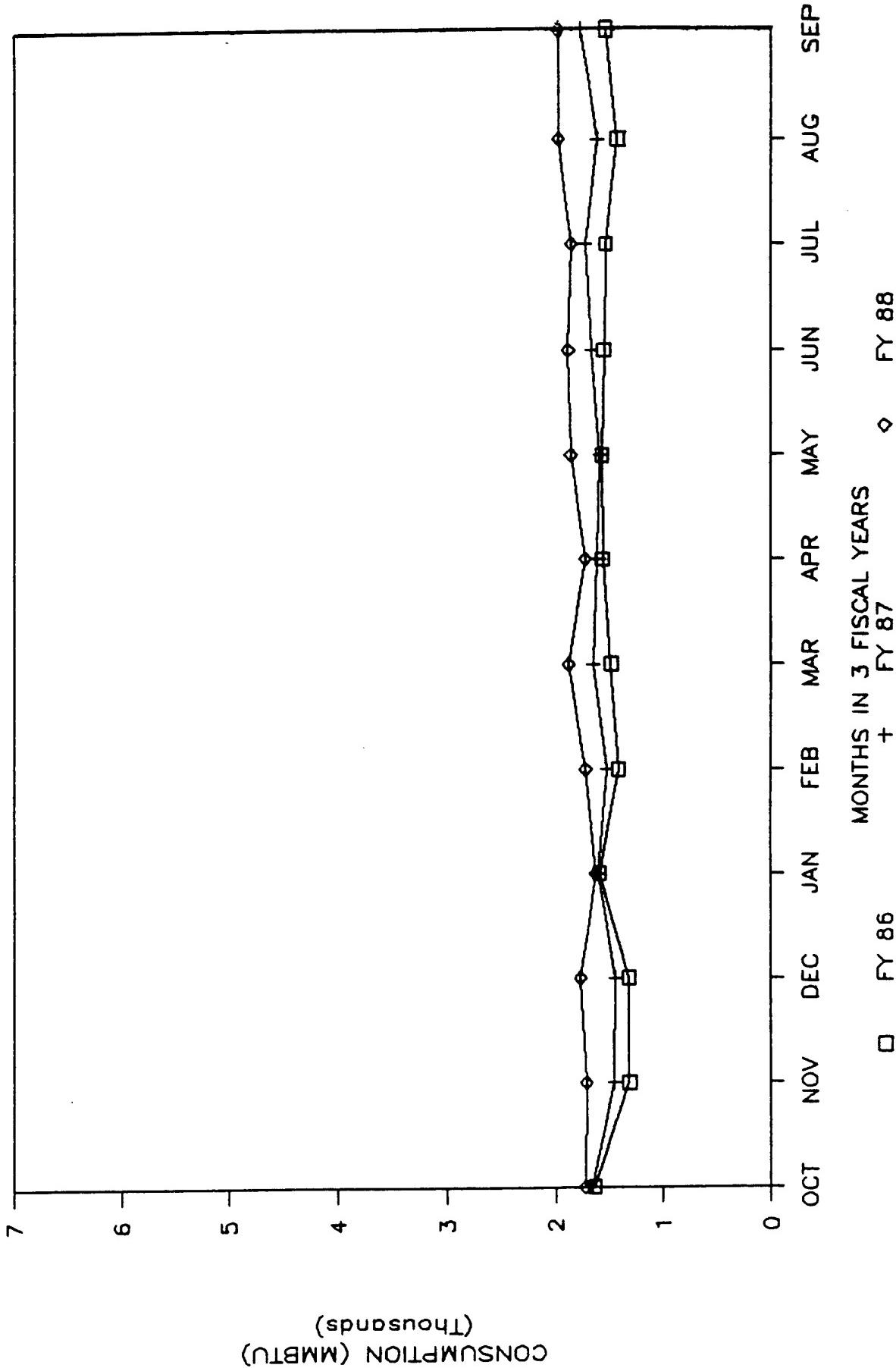


FIGURE 4.7.2 GRUENSTADT UTILITY HISTORY
BAKERY NATURAL GAS

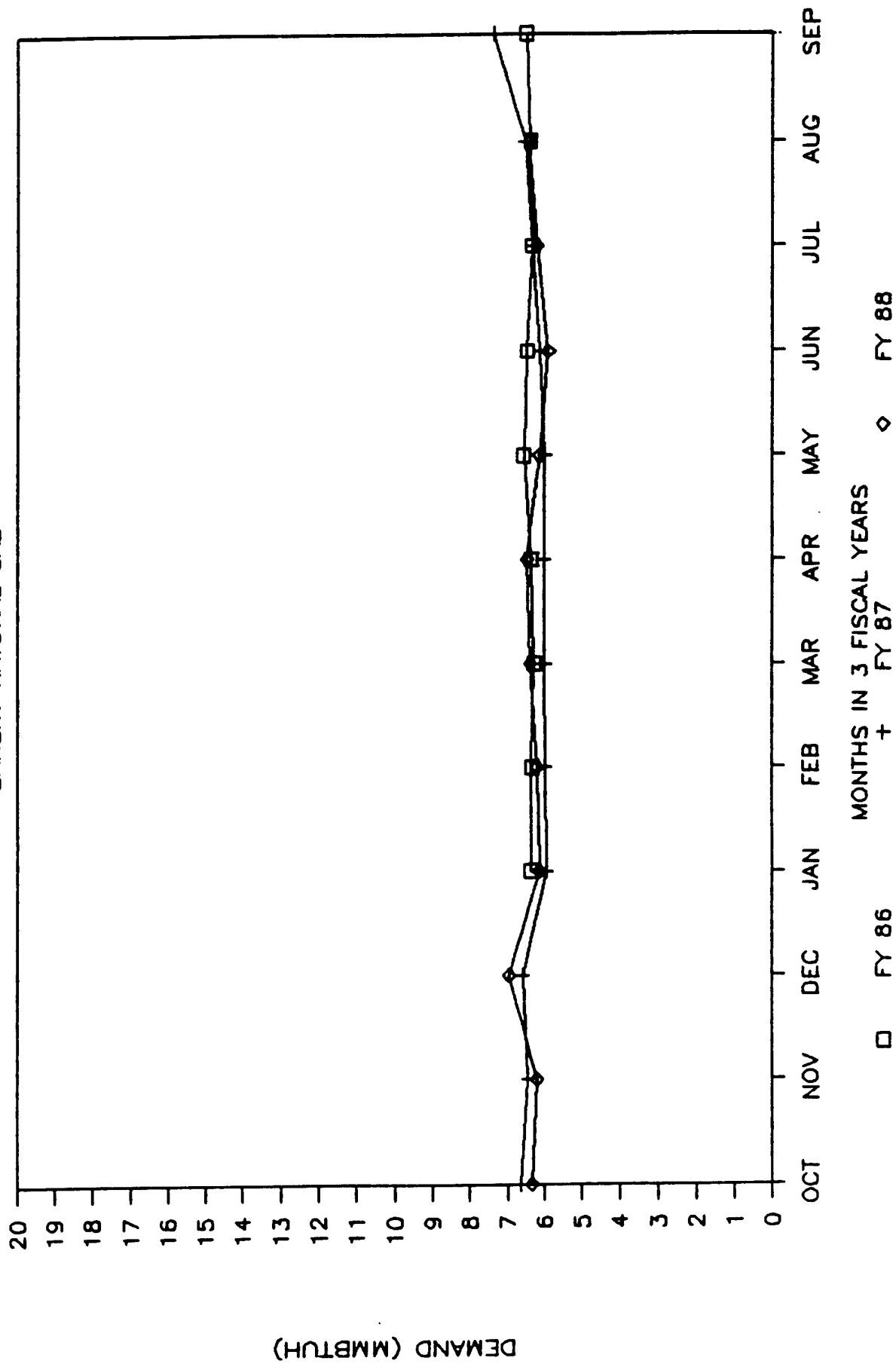
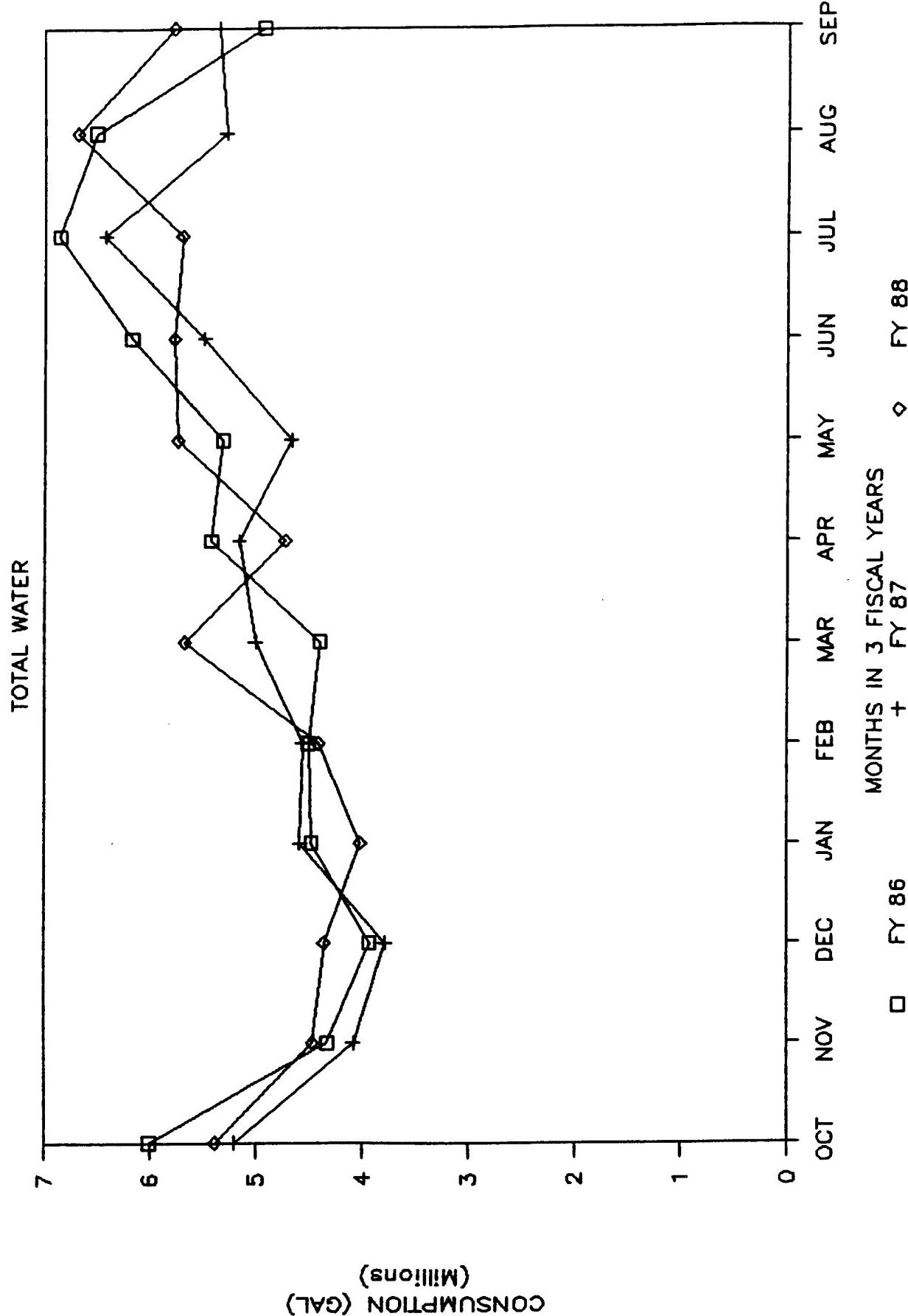


FIGURE 4.8.1

GRUENSTADT UTILITY HISTORY



- 5.1 SECTION OVERVIEW
- 5.1.1 GENERAL DESCRIPTION
- 5.1.2 MISSION OF THE AAFES PRODUCTION FACILITY
- 5.1.3 FACILITY OPERATING SCHEDULE
- 5.1.4 MANNING
- 5.1.5 PROFITABILITY
- 5.2 BAKERY AND SWEET GOODS PRODUCTION
- 5.2.1 PRODUCTION EQUIPMENT CHANGES
- 5.2.2 SCHEDULING/LOADING OF PRODUCTION EQUIPMENT
- 5.2.3 AUTOMATED CONTROL OF PRODUCTION EQUIPMENT
- 5.2.4 IMPROVE LAYOUT AND SPACE UTILIZATION
- 5.2.5 CONSOLIDATION OF REQUIRED SPECIAL ENVIRONMENTS
- 5.2.6 PRODUCTION EQUIPMENT MAINTENANCE
- 5.2.7 IMPROVED METHODS & CONTROLS
- 5.2.8 ZONE EXISTING MULTIPLE USE FACILITIES
- 5.2.9 RESCHEDULE UTILIZATION OF EXISTING FACILITIES
- 5.2.10 CONSOLIDATE SERVICES INTO PERMANENT BUILDINGS
- 5.3 ICE CREAM PLANT
- 5.3.1 PRODUCTION EQUIPMENT CHANGES
- 5.3.2 SCHEDULING/LOADING OF PRODUCTION EQUIPMENT
- 5.3.3 AUTOMATED CONTROL OF PRODUCTION EQUIPMENT
- 5.3.4 IMPROVE LAYOUT AND SPACE UTILIZATION

- 5.3.5 CONSOLIDATION OF REQUIRED SPECIAL ENVIRONMENTS
 - 5.3.6 PRODUCTION EQUIPMENT MAINTENANCE
 - 5.3.7 IMPROVED METHODS AND CONTROLS
 - 5.3.8 ZONE EXISTING MULTIPLE USE FACILITIES
 - 5.3.9 RESCHEDULE UTILIZATION OF EXISTING FACILITIES
 - 5.3.10 CONSOLIDATE SERVICES INTO PERMANENT BUILDINGS
-
- 5.4 MEAT PROCESSING
 - 5.4.1 PRODUCTION EQUIPMENT CHANGES
 - 5.4.2 SCHEDULING/LOADING OF PRODUCTION EQUIPMENT
 - 5.4.3 AUTOMATED CONTROL OF PRODUCTION EQUIPMENT
 - 5.4.4 IMPROVE LAYOUT AND SPACE UTILIZATION
 - 5.4.5 CONSOLIDATION OF REQUIRED SPECIAL ENVIRONMENTS
 - 5.4.6 PRODUCTION EQUIPMENT MAINTENANCE
 - 5.4.7 IMPROVED METHODS AND CONTROLS
 - 5.4.8 ZONE EXISTING MULTIPLE USE FACILITIES
 - 5.4.9 RESCHEDULE UTILIZATION OF EXISTING FACILITIES
 - 5.4.10 CONSOLIDATE SERVICES INTO PERMANENT BUILDINGS

5.1 SECTION OVERVIEW

This section is intended to audit the bakery, ice cream and meat plant operations in order to document production approaches and equipment to determine the capacity utilization, efficiency and potential areas requiring change, if any.

Tables and charts referenced throughout this section are included at the end of this section.

5.1.1 GENERAL DESCRIPTION

Baked goods are produced in site Building 3555b. This is the most north easterly building on the site, as indicated in Sketch 5.1.1. The production areas within Building 3555 are indicated in Sketch 5.1.2. The "b" portion of Building 3555 is in the north western section of the building. Ice cream and meat products are produced in site Buildings 3555c and 3555d, respectively, which are located in the south eastern portion of Building 3555. The "a" portion of Building 3555 is used for administrative operations purposes and only represents less than six percent (6%) of the bulding space. Consequently, the major portion of Building 3555 at the Gruenstadt site is utilized for AAFES production purposes.

5.1.2 MISSION OF THE AAFES PRODUCTION FACILITY

The mission of the AAFES production facility is to produce baked goods, ice cream and butchered meat products in an economical manner for supply to the United States troops and their dependents at cost effective prices. The products to be produced shall provide a range of goods which will provide a feeling of "home" to AAFES's customers by nature of having available the items which could and would normally be purchased at home. While providing a wide range of products, AAFES is charged with the operation of the facility in a business-like manner and creating a profit, yet, the final cost to their customers shall be affordable and competitive.

5.1.3 FACILITY OPERATING SCHEDULE

The facility operates primarily on a five day a week basis for normal operations. Saturday and Sunday operations are minimal unless special circumstances intervene.

As may be seen in the "Building 3555 Production Schedule", Figure 5.1.3, the facility operates virtually around the clock during the week.

The bakery portion of operations are scheduled at staggered times, as is normal in commercial bakeries, to provide an orderly flow of production without labor waiting for something to do. Liquid Sponge, Mixing, Make-Up, Baking and Packaging of the bread and roll operations have sequential staggered starts because of the operation complexity. The Pizza, Donut, Pastry and Cake operations are more crew related and their production is operated on a team basis, therefore their operations are more continuous from a labor standpoint. Roll production is primarily a three shift operation, while bread, cakes and pizza operate mainly in two shifts. The donuts and sweet goods activities are one shift operations.

Ice cream and meat plant operations are accomplished in one shift, except when summer demand increases working hours past the day shift in the ice cream plant.

5.1.4 MANNING

Manning of the production operations are consistent with commercial operations. To determine the present associated manning impact by plant operation, the October 1988 Monthly Labor Summary was checked. The results of this check are shown in Table 5.1.4.

Figure 5.1.5 is a pie chart indicating the allocation of employees in the major production areas. The bulk of the operating work force is in the bakery operation. Because of the bakery having the major portion of operations this was the area of greatest concentration, since purely numerically this area presents the greatest opportunity (a 10% reduction in the bakery operations would be over six times greater than a 10% reduction in the meat plant).

5.1.5 PROFITABILITY

The bakery started operations in February 1982. Accounting for recruiting and training of operators as well as equipment shakedown, consistent profits began to be produced in March 1983. The accumulative finances of the operation became profitable in December 1984. This financial history of profitability is consistent with, or slightly better than, most commercial bakeries and indicates a management awareness and method of operation which is cognizant of the prime mission of AAFES.

5.2 BAKERY AND SWEET GOODS PRODUCTION

5.2.1 PRODUCTION EQUIPMENT CHANGES

Presently there are two projects in Procurement to replace bakery equipment. They are:

1. Replace the present Anetsburger pastry make-up table with a new Rykart table.
2. Up-grade the present donut packaging.

Both of these projects are needed and since they are already in process, they need not be addressed any further.

A project to upgrade the flour system to complete computer control (CIM) and add additional silo capacity for flour and sugar is scheduled for board presentation in January 1989. The intent is to bring milled flour directly from the United States rather than depend on the German millers. This will result in significant flour cost savings and the elimination of some transportation costs. The computerization of the system will provide more accurate use of the flour, thus, eliminating some waste which results in cost savings. Since flour will be brought directly from the United States, this project requires additional silos for storage of flour to take into account the in process shipment deliveries, even with a "just in time" inventory system. The project is highly worth while but caution must be exercised in the storage cycles as flour stored over twenty-eight days is susceptible to insect infestation and silo fumigation must be regularly accomplished. The equipment upgrade would be supplied by Reimelt Corporation who was the supplier of the present flour system.

There are two projects that have been identified by local personnel but have not yet been funded. These projects are:

1. Modification of the compressor for the Triumph sweet goods mixer from a single to a twin screw. This project will provide better process control and result in process quality and productivity improvements.
2. Replacement of the Alvey pan washer. Presently the old Alvey pan washer is not capable of completing all the pan washings necessary. Because of space limitations within the wash room and the bakery in total, addition of a second pan washer is not practical. The pan washing operation requires space to stage racks of pans waiting to be washed, as well as storage of racks of pans that have been washed. The present Pan Washing Room just about supplies the needed space; therefore, making the addition of a second pan washer impossible. The logical, and practical, solution is the replacement of the old inefficient pan washer with a new piece of equipment. A new washer will not only assist in the orderly operation of the bakery, by means of greater pan washing capacity, but it also will provide some energy savings through less loss of hot water and steam because of leaks and a more efficient operation which will result in less energy per pan washed.

There are three equipment types that appear to be approaching their useful life. These pieces of equipment are:

1. The donut fryer. This piece of equipment was old when it was brought into the Gruenstadt bakery from the Frankfurt bakery. Some rehabilitation of the fryer was accomplished in the move but now it is seven years older and will be ready for replacement shortly.
2. The bread dough dividers. These pieces of equipment were acquired new when the Gruenstadt bakery was built. The accuracy of the dividers controls the profit of the bakery to a large degree, in fact in the industry they are known as the "cash register of the bakery". When the divider is not accurate, you either over scale the product which in turn is like giving product away, or you under scale and cheat the customer. In either case this is not a good situation and these dividers have been in operation long enough to warrant a general rehabilitation to insure their accuracy.
3. The bread dough rounders. They work in concert with the bread dividers. While the rounder does not have the accuracy requirements of the divider, it is a complementing piece of equipment and as such should be rehabilitated with the dividers.

There are three pieces of equipment which are restricting production.

1. The present sweet goods retarders are being used to full capacity. The retarders are fully loaded with products and doughs requiring over night retarding which results in the inability to produce any more of that product. Additionally, the old retarders must be loaded by pushing product up a ramp, thus making operations difficult. A judgement must be made whether any additional product might be required, and if so, will the additional sales warrant the expense of acquiring an additional retarder, or, replacing the smaller retarder with a larger one.
2. Roll line production is primarily limited by mixing capacity. The line basically operates on a three shift basis. The basic limitation on mixing is 88 packages per minute, as indicated in Table 5.2.1. The next limitation in the line is 100 packages per minute. Therefore, increasing mixing by more than 13.6% (100/88) would be unwarranted as it would result in creating excess mixing capacity. The 13.6% mixing capacity increase would result in changing the mixer from 1600 to 1800 pounds per dough. At 3.3 doughs per hour, this additional 660 pounds of dough per hour would have to be supported by the Liquid Sponge System whose capacity would have to be checked. Another solution to the problem, should the capacity be required, and assuming personnel could be obtained, would be to make shifts 2 and 3 the primary roll production shifts with limited production on shift 1. This would not effect the capacity of the Liquid Sponge System since the bread line, which is the prime user of the system, does not operate on shift 3.

At the present time roll production is limited on shift 3, and not at full capacity on shift 1, therefore, if extra capacity is required there is still capacity within the present equipment. A larger roll mixer only need be acquired if capacities reach the saturation point.

3. During slower production days the bakery produces product for frozen inventory which will be shipped to distant locations, such as Turkey. The product is presently made, packaged, cased and placed in a holding freezer for freezing. This procedure is considered by the baking industry to be harmful to the quality of the product as the staling of baked products increases rapidly in the "staling zone", which is reached while lowering the product temperature between 28 and 55 degrees Fahrenheit. Tests conducted at other bakeries have revealed that this method can take up to two weeks before the product reaches zero degrees core, the ideal frozen state. Additionally, by this slow freezing process the product remains in the staling zone for a protracted period of time which deteriorates its' quality. A method used to over come this problem, and lower the product temperature as rapidly as possible, is the use of a blast freezer. This can be done by either cryogenic (Nitrogen) or mechanical freezing techniques. The use of a Nitrogen type system freezes the product quickly and it is not very expensive to install. The problem with Nitrogen freezing is, their long term energy costs of operation are much greater than mechanical systems and there is a tendency to have freezer burn on unprotected product. Mechanical systems are much more expensive to install but their long range energy costs are lower than cryogenic systems. The practicality of the installation of a blast freezer to improve the quality of the products supplied to distant locations becomes a matter of question. The improved quality will be noticed by individuals with a sharp palate, and others will probably know something is different but not be able to discern what it is. The questions are, how satisfactory is the quality of products in distant locations, and would improved quality increase sales sufficiently to warrant the expense of the blast freezing? It is safe to assume that the blast freezing operation will increase energy consumption since it will not be required every day which will mean that the temperature will creep up when the system is not in use, and added energy will be required to lower the temperature when the system is required. Some of this energy used in blast freezing will reduce the storage energy required as the products would enter storage at a lower temperature and the storage area would only have to maintain the products, not freeze them as that would already have been accomplished by the blast freezer. Should a decision be made to pursue the blast freezing of bakery products, the project should be combined with the current study to size and locate a completely new frozen goods warehouse as there would be difficulty locating the blast freezer in the current bread and roll operation.

5.2.2 SCHEDULING/LOADING OF PRODUCTION EQUIPMENT

Monthly issue (sales) of bakery products were researched in an effort to determine what is the proper production load to use for comparison of bakery capacities. Data for the most current twelve month period from November 1987 through October 1988 was obtained in millions of pounds of products issued. The summary of that data is shown in Table 5.2.2:

Analysis of the data revealed in Table 5.2.2 that the most recent month which represented the average monthly sales was April 1988. The details of the April 1988 issue were obtained in order to develop Table 5.2.3 - "Actual April 1988 Bakery Units Issued". This table documents the product number, description, unit of issue and actual units issued for each individual product. From this data the table shows the development of the daily average requirement by product, plus the daily production hours and subsequently the units per minute for each product category. This data for April 1988 provides the basis upon which to make a comparison of bakery capacities and needs for scheduling and loading purposes.

Analysis of the capacities and limitations of the bread line production equipment was undertaken as shown on Table 5.2.4, "Bread Line Capacities & Limitations - Loaves Per Minute." This table depicts each of the bread line products indicating product number, description, sales unit, scaling and baked weight in ounces, the pan dimensions and number of pans in each strap. Using this data plus the production process parameters (e.g. time, equipment size etc.) the limitations of each operation in the bread line were calculated in loaves per minute. Finally from this data, an analysis was made to document the limiting operation and its related numerical limit. Analysis of the limiting factors and their associated limitations reveals a mixture of items which is indicative of a well balanced operation. Additionally, the numerical limiters are sufficiently above the average requirements which were developed in Table 5.2.3, "Actual April 1988 Bakery Units Issued." It is therefore reasonable to conclude that the bread line is adequate and can handle sales requirements without any additional equipment. While analyzing the bread line production capacities, attention was placed upon actual manning. The bread line was separated into "Bread Line Make-Up/Baking Ideal Manning" and "Bread Line Packaging Ideal Manning". This data separation was made as the packaging operation, by nature and design, must be more labor intensive than the make-up and baking operations. The reason for this is that when a malfunction occurs in the packaging operation, the operation can not stop as the product is flowing through the line and it can not be shut off. The malfunction must be overcome manually by stacking off product or other means. The "Bread Line Make-Up/Baking Ideal Manning" and "Bread Line Packaging Ideal Manning" data is presented in Table 5.2.5 and Table 5.2.6. These tables for these two areas of operation, itemize the individual job descriptions and indicate the number of operators required on each shift for each of the job descriptions as well as the appropriate totals. This analysis

allowed the development of the following comparison, shown in Table 5.2.7.

Table 5.2.7 recognizes the fact that employees have six weeks vacation which requires replacements, plus, plant absentees (7.6% average absentee rate supplied by plant personnel) must have their positions covered. Despite management encouraging employees to spread out the vacations and minimize impact on production, the fact remains that trained operators must be available to cover these positions. The chart very clearly shows that the actual manning of the bread line is under control and in fact operating below what it could be, thereby indicating efficient labor operations based upon industry standards.

Analysis of the capacities and limitations of the roll line production were undertaken in a similar manner as the efforts engaged in for the bread line. This analysis is shown on the "Roll Line Capacities & Limitations - Packages Per Minute" chart on the following page. As with the bread line the chart depicts each roll line product indicating its number, description, sales unit, scaling and baking weight per sales unit in ounces, the pan dimensions and number of individual pieces in each pan. This data was then extrapolated using the production process parameters to determine the limitations of each operation in the line, calculated in packages per minute. The final step of this phase was the analysis of the data to identify the limiting production factor and its' numerical limitation. As previously noted, the limitations center heavily in the mixing operation. However, since the limitations do not exceed the average requirements of Table 5.2.3, "Actual April 1988 Bakery Units Issued," it is reasonable to conclude that capacity has not been exceeded. It must be noted that there is less of a delta between the issue average and the limitation on the roll line than there is on the bread line. Part of this is accounted for by the fact that the roll line has longer hours of operation. Additionally, as previously noted in the discussion of "Production Equipment Changes", there are alternate methods to increase production without impacting the Liquid Sponge System, and possibly without the purchase of additional equipment.

Manning of the roll line was analyzed in the same manner as the bread line. The operations were separated into Make-up/baking and packaging for the same reason they were separated on the bread line. Table 5.2.8, "Roll Line Make-Up/Baking Ideal Manning" and Table 5.2.9, "Roll Line Packaging Ideal Manning" detail the job descriptions, operators required in each job by shift, as well as the total operators required in each of the categories. This data became the basis for the analysis of Table 5.2.10, "Roll Line - Actual Operators Required vs. Payroll Operators."

Table 5.2.10 takes into account the same factors as were recognized on the bread line. Those factors are that operators have six weeks vacation and absentees are a fact of life in any production operation. Both of these factors must be provided for, since the operating positions must be manned even when the

regular operator is absent or on vacation. As with the breadline, the roll line chart vividly depicts that the manning of the operation is under control and not over staffed.

Analysis of the donuts, sweet goods, cakes and pizza area requires a different approach than the bread and roll lines in the case of the AAFES bakery. The donut operation while somewhat machine controlled because of mixing, depositing, frying, cooling, sometimes coating and finally packaging, the volume requirements are such that the operation becomes a team approach rather than a steady production position for each operator. This same analogy is also true in the pizza operation, and it is the rule of operation in sweet goods and cakes. Due to these conditions, detail through put analysis of individual pieces of equipment in these areas is superfluous. While there is a greater machine control in the donut and pizza areas, there is almost no machine control in the sweet goods and cakes areas, they are mostly operator paced and controlled. Review of the product list in the sweet goods and cakes areas, as shown on Table 5.2.3, "Actual April 1988 Bakery Units Issued" reveals a high percentage of products that are hand made or formed rather than machine extruded or pressed. The Anets table operation in the sweet goods area is basically a manual operation with machine assistance. The cake decorating and packaging, while obtaining assistance from screen projection, is still a manual job. With the exception of the pizza, all of these operations are one shift due to the volume requirements. The second shift operation of layer making in the cake area is purely for convenience and product flow purposes to have the cooled layers ready for the people to work on the next day. Analysis of the Units per Minute requirements from Table 5.2.3, "Actual April 1988 Bakery Units Issued" for these areas, reveals a minimal production load requirement which supports the fact that these areas are primarily one shift operations.

As previously discussed in the "Production Equipment Changes" Section 5.2.1, the only question of limitations in these areas is the crowded retarder box situation, which, because of requirements may not need to be alleviated. Additionally, the project to upgrade the donut packaging will assist this area.

Since the donuts, sweet goods, cakes and pizza areas are primarily a labor controlled manning situation, a labor analysis was made. For reasons of consistency, the approach used in the bread line and roll line labor loading analysis was also used for the donuts, sweet goods, cakes and pizza areas. Refer to Table 5.2.12, "Donuts, Sweet Goods, Cakes & Pizza Make-Up Manning" and Table 5.2.13, "Donuts, Sweet Goods, Cakes & Pizza Packaging Manning." These tables are in the same format as the tables for the bread and roll lines, previously presented. They separate the four individual areas (eg. donuts, sweet goods, cakes and pizza) and show for each area the job descriptions, operators on each shift and total operators. From these tables analysis and comparison of payroll operators to manning was possible. This analysis was completed and is shown in Table 5.2.11.

The previous "Actual Operators Required vs. Payroll Operators" chart results in the same answer for these areas as was seen in the bread line and roll line areas. Actual manning is being implemented slightly below reasonable requirements which shows that the operation is under control.

5.2.3 AUTOMATED CONTROL OF PRODUCTION EQUIPMENT

The most obvious area adaptable to automated control of production equipment is the flour system. Since there has already been a study made of this area and the project is scheduled for presentation to the board in January 1989, this area will not be discussed here.

Other areas of the bakery, which on the surface appear to be open for automation, are the packaging areas of the bread and roll lines, the sweet goods make-up, cake decorating and order preparation. These areas, while labor intensive, do not have all the requirements which would lend themselves to successful and economic automation. The packaging of bread and rolls is currently automated to the extent of the state of the art available today. Additionally, these areas must be as mechanically reliable as possible since a malfunction must be manually overcome (product removed from the line) as the flow of the product can not be stopped. In both the sweet goods make-up and the cake decorating areas, volumes are not sufficient to warrant extensive automation and the total labor content is small enough that a 15% reduction of labor would not pay for the cost of automation. The jobs in these areas, where practical automation is available, are the table operators and icers in sweet goods and the decorators in cakes. There are only nine people in these jobs and a 15% reduction would be just over one person. There would have to be a significant increase in volume before these areas would warrant further automation, and at that point the automation could be instituted to increase the volumes without increasing the labor. The order preparation area is highly manual because of the constant change every day as to what products, in what quantities, each order receives. The method used by AAFES in this area is the same as used in commercial bakeries and has proven over time to be the most effective.

5.2.4 IMPROVE LAYOUT AND SPACE UTILIZATION

The present layout of the bread and roll lines leaves little space for use by other activities. Additionally, this layout is dictated by product flow and machine placement to meet that flow in the proper manner. The balance of the bakery is segregated in an attempt to keep like production areas contained (eg. donuts, cake, etc.). Because of the AAFES mission to supply a wide range of products so that the troops and their dependents feel at "home", the eastern portion of building 3555b is crammed with the non bread and roll baked goods lines. This wide variety of lines consumes space yet the volume requirements barely warrant a one shift utilization. Although these areas could use additional space for smoother work flow, there is not sufficient justification since added space would require either construction

or the elimination of some product lines to provide more space for other product lines. From a positive stand point, the current layout for the equipment required, does effectively use the space available and minimizes wasted areas.

5.2.5 CONSOLIDATION OF REQUIRED SPECIAL ENVIRONMENTS

Within the bakery operation there are no special environments required, other than a clean and sanitary building with normal comfort level atmospheric conditions. Should a decision be made to install a blast freezer for products requiring distant shipment, that operation should be coupled with the refrigeration systems of either the Ice Cream or Meat Plants.

5.2.6 PRODUCTION EQUIPMENT MAINTENANCE

A Preventive Maintenance program exists within the bakery. It is manually implemented by thirty-nine maintenance workers which are regularly assigned to the operation. According to information obtained, in the past six years there has only been one production day lost, on one line (rolls), due to a major equipment failure. This record speaks for itself that the Preventive Maintenance system is working, and working well. There are current plans to automate the administration of the system in Fiscal Year 1989 with the use of modified software and a Personal Computer. This step will provide better flow of work orders and their completion follow up, and will develop a historical data base which will lend itself to an even more effective system.

5.2.7 IMPROVED METHODS AND CONTROLS

The greatest step of improved methods and controls to reduce waste is already in process. That project is the computer control and automation of the flour system. A second major area to improve controls and reduce energy waste is the replacement of the Pan Washer. Presently, the current pan washer can not keep up with, nor does it satisfactorily meet, the pan washing requirements and at times pans require multiple washings. The replacement of this Pan Washer with a modern more efficient machine would assist the production operations and at the same time reduce waste of water and the energy to heat that water by reducing leaks in the system.

5.2.8 ZONE EXISTING MULTIPLE USE FACILITIES

The current bakery in building 3555b is primarily divided into two areas. The western portion housing the bread and roll lines and the eastern portion which contains the balance of the operation. The bread and roll operations are two plus shift activities. The balance of the bakery is mostly a one shift operation. The entire building is bakery operations and as such is all related. The only potential zoning that could be accomplished is the separation of the bread and roll lines portion of the building from the rest. The only practical advantage this could supply is that on shift 3, when there are

virtually no operations in the eastern portion of the building, the heat could be banked for several hours.

5.2.9 RESCHEDULE UTILIZATION OF EXISTING FACILITIES

We do not see any potential of rescheduling the utilization of the bakery facilities. The bakery as a unit accomplishes a very valuable mission in the supply of baked goods. This mission is accomplished in an economical manner as evidenced by the profitability of the operation which winds up benefitting the troops and their dependents. Elimination of small product lines to improve operations would be contrary to the mission of making the troops feel at "home".

Based upon the production requirements, the organization and assignment of people and facilities to meet those requirements is well managed and effectively meets the mission. Disruption and reorganization of this operation would be counter productive and most likely would produce negative effects.

5.2.10 CONSOLIDATE SERVICES INTO PERMANENT BUILDINGS

Bakery operations at the Gruenstadt Depot are housed in building 3555. Although this building has basically four sections (a, b, c, d) it is still primarily a single permanent building. We see no advantage to moving this operation into another building which may be better constructed or more modern in nature.

5.3 ICE CREAM PLANT

5.3.1 PRODUCTION EQUIPMENT CHANGES

Based upon interview information it is believed that there is a Feasibility Study in process to size and locate a completely new frozen goods warehouse. This project is of major importance to the Ice Cream Plant as current space limitations for production as well as storage are impeding operations. The implementation of this project could allow the re-layout of the ice cream production facilities and the addition of needed equipment which would vastly improve operations. This same study, if approved and implemented, would impact on the Meat Plant, general depot storage and provide the possibility of a blast freezer for bakery operations. As this is a separate major study project, it will not be expanded upon here, other than to note its' importance on the operation in total.

There are three Ice Cream Plant items slated for replacement or rehabilitation during Fiscal Year 1989. These items are:

1. Replace a single barrel freezer
2. Replace a 500 gallon brine cooled holding tank
3. Computerize the CIP (Clean In Place) system

In each case, from observation and discussion with plant personnel, they appear to all be warranted projects. Since these projects are in process of imminent installation they are only mentioned here for documentation, rather than analysis.

Operationally, a major equipment short fall is the lack of in-line freezers to freeze boxed/packaged products. While this would require expenditure of funds to implement, the basic problem is the lack of space to install the systems in the ice cream plant lines. Currently the boxed/packaged product is placed in corrugated cases, tightly packed on a pallet and placed in the holding freezer. This method does not allow timely hard freezing of the product because of the insulation created by the cases and the tight packing on the pallet. In order to gain the space needed, the new frozen goods warehouse previously noted would have to become a reality, then the layout of the ice cream room could be changed and hopefully rearranged so that these freezers could be included.

5.3.2 SCHEDULING/LOADING OF PRODUCTION EQUIPMENT

Based upon data available in the ice cream plant, an investigation into the capacities and limitations of the production equipment was undertaken. The results of that investigation are summarized in Table 5.3.1, "Ice Cream Plant Capacities & Limitations - Pieces Per Minute." As may be noted from the table, the basic limitation is most often the wrapping operation.

With the ice cream plant operating on a one shift basis, except for peak season demands, it would appear that the demands can be met with current equipment. However, further investigation into manning was undertaken. From information provided by ice cream plant personnel Table 5.3.2, "Ice Cream Plant Manning" was developed. Additionally, copies of Figure 5.3.3, "Production - EIA Ice Cream Plant" and Figure 5.3.4, "Productivity - EIA Ice Cream Plant" were obtained from plant personnel for analysis.

Analysis of this data indicates that the staffing by operator position is not excessive. Additionally it points out the fact that as production increases, so does the gallons per man hour. This leads to the obvious conclusion that the ice cream plant is under utilized and equipment through put capacities are greater than requirements will allow use of. Additionally, this data points up the tremendous requirement fluctuation due to seasonality of demand, which substantiates the need to add additional help in the peak summer months. It would appear that a major marketing study should be engaged in to determine the possibility of using some capacity of the plant as a third party producer, the potential of introducing new products which would have their demands when the current products have minimal requirements, and a detailed analysis of past sales history coupled with shelf life data to attempt to level production by producing for inventory those products that have minimal storage deterioration and sales fluctuation risks.

5.3.3 AUTOMATED CONTROL OF PRODUCTION EQUIPMENT

Automated control of the production equipment in the ice cream plant can not be justified. One of the major purposes of automated control is to reduce labor. Current manning of the ice cream plant equipment is mostly one operator on an operation. Automation would have to make it a zero operator situation and the system would have to be so reliable that a system monitor would not be required. Additionally, without spending any money for automation, productivity would increase simply by increasing requirements. The current systems productivity capability is being hampered by requirements which are too low to allow full utilization of the equipment.

5.3.4 IMPROVE LAYOUT AND SPACE UTILIZATION

Currently the ice cream plant layout is over crowded. As previously noted there are additional pieces of equipment which would enhance the operation, but because of space limitations, they can not be added. The realization of the new frozen goods warehouse project could provide the space to make a meaningful layout in the ice cream plant. At the present time, with the present space available, any equipment layout changes would be compromises at best.

5.3.5 CONSOLIDATION OF REQUIRED SPECIAL ENVIRONMENTS

The ice cream plant has two special environments to deal with. These environments are the two different temperature control areas of the ice cream production room and the hardening and storage freezers.

While the temperature control conditions of the ice cream plant and the meat plant have similarities, it is not practical to try and combine these operations. This resistance to the combination of these operations assumes that the Veterinary Corp places the same restrictions on AAFES operations as the USDA and FDA places on commercial operations in the United States. U.S. plants are not allowed to combine meat operations with other food operations unless extensive sanitation restrictions are imposed. These restrictions most frequently involve expensive construction requirements, and they restrict an orderly flow of the operation. It is for these reasons that these operations are not combined in U.S. plants unless it is an absolute, no other choice situation. Even if the two operations could be combined, the sanitation of both operations has different restrictions which would not be conducive to side by side production. At best, only systems serving these areas may possibly be combined.

5.3.6 PRODUCTION EQUIPMENT MAINTENANCE

A Preventive Maintenance program is in effect in the ice cream plant. The system is working well as evidenced by the fact that no major breakdowns have occurred which halted production for any extended period of time. The personnel to provide the maintenance service are drawn, as required, from the Central Depot Maintenance Pool. This pool has twenty-three people with a complement of skills to provide the service required by the ice cream plant.

As noted in the bakery portion of this report, the current Preventive Maintenance program is manually administered. Presently software is being modified to automate the system on a personal computer. This modification is also applicable to the Preventive Maintenance program in the ice cream plant.

5.3.7 IMPROVED METHODS AND CONTROLS

With the present space limitations in the ice cream plant, improved methods and controls to reduce scrap have extremely limited possibilities. The computerization of the CIP system will definitely aid the operation through the consistent operation of the Clean In Place system. As previously noted in other sections of this report, if additional space could be gained through the implementation of the new freezer warehouse project, layout revisions could be made in the ice cream plant which would enhance the operation. Until it is known how much space might be gained, and where that space is any layout effort would be fruitless.

5.3.8 ZONE EXISTING MULTIPLE USE FACILITIES

The ice cream plant is currently zoned into two areas, the ice cream room and the hardening and storage areas. Any further zoning of this activity is meaningless.

5.3.9 RESCHEDULE UTILIZATION OF EXISTING FACILITIES

The only rescheduling of utilization of the existing ice cream plant facility would be to completely discontinue the production of ice cream and turn this facility over for production of some other item. With the mission of AAFES dictating the requirement to supply items to the troops, discontinuing ice cream production would be counter productive. If the alternative of buying all ice cream for the troops was implemented, the profits from the operation which benefit the troops in the long run would be lost.

5.3.10 CONSOLIDATE SERVICES INTO PERMANENT BUILDINGS

The ice cream plant is located in a permanent building. The study in process for the new freezer warehouse would benefit the ice cream plant and would help consolidate outside storage and reduce transportation costs. Since this is a separate study of major magnitude it will not be addressed in detail here.

5.4 MEAT PROCESSING

5.4.1 PRODUCTION EQUIPMENT CHANGES

At the present time there does not appear to be any dire need to change any production equipment, nor are there any currently planned projects, since some storage room renovations have recently been completed.

The project under study of a new frozen goods warehouse could have a major impact on the meat plant. This project, in addition to providing needed storage, could also provide the vehicle to help improve the layout of the meat plant. Additionally, should this project occur and re-layout of the meat plant be undertaken, it would provide the practicality of upgrading the meat plant floor which the Veterinary Corp has deemed a sanitation problem.

5.4.2 SCHEDULING/LOADING PRODUCTION EQUIPMENT

In order to be consistent with the other areas of this report, so that all areas of the facility are investigated and analyzed in the same vain, an investigation into the capacities and limitations of the meat plant operation was undertaken. Capacity and through put information was obtained from the operating personnel and summarized in Table 5.4.1, "Meat Plant Capacities & Limitations - Pounds Per Hour." The table identifies each product and the major through put steps of its process, indicating the pounds per hour capability of each step. The overall meat plant processing for block grinding, mixing and final grind, Formax forming and cylinder stuffing, slicing, manually performed operations, and packing are identified and the pounds per hour capability for each of these operations is shown on each product. This highlights what steps each product goes through, as indicated by the rate shown. It should be noted that all products do not go through all processes. The chart also identifies, from the previously documented data, what the limiting process is for each product item and its' related numeric limitation. Analysis of the limiting factors of the meat plant shows a typical grouping of items as is seen in a commercial operation. It also points out the fact that the operation is highly manually controlled, rather than machine oriented as is traditional in meat processing operations.

Manning and operation of the meat plant is highly influenced by the products and quantities being processed. At the present time there are twenty-three operators, even though there is authorization to have up to thirty-seven operators. Based upon information from plant personnel, it is expected that when the plant is producing for Burger King, the actual number of operators will have to be increased to handle the volume. Despite the complexity of manning, and with information from plant personnel, an investigation into the standard manning of operations was undertaken. Since the various products require different manning of operations, it was decided to develop the

ranges of operators required for the different operations within an area. The result of this effort is shown in Table 5.4.2, "Meat Plant Crewing Set-Ups." The chart separates the major areas of operation of the meat plant, and for each area, notes the range of operators that can be engaged in the individually identified activities. It identifies each of the meat plant activities, even though all areas do not have all activities. Within the activities of unwrap/prepare, final grind/chopper bowl, forming/stuffing, weigh & assemble, machine operator, portioning, packers, weigh & pack and utility operators, the range of operators from the lowest to the highest number, as required by the products, is shown. Additionally, the chart shows the area total operators in the ranges required from lowest to the highest. It should be noted that the activities which have a single number in the total just happen to require the same total number of operators when the lowest requirement is added as when the highest requirement is added. Caution should be exercised with the use of this chart because of the complexity of the operation. The chart shows ranges of operators required by activity in an area, therefore, single number totals can not be obtained since the chart is not additive, only the ranges of operators required can be determined.

Tables 5.4.1 and 5.4.2 clearly indicate that there are no capacity limitations at the present time, from a processing view point. In gathering the base data from the meat plant personnel it was noted that some of this base data was for an operation on a larger scale, as this one used to be. It would appear that the meat plant has one of the same problems as the ice cream plant. The plant can successfully meet requirements in a one shift operation, and there is more capacity than there is demand. As proposed for the ice cream plant, a marketing study should be undertaken to develop additional products which will increase the plant requirements.

5.4.3 AUTOMATED CONTROL OF PRODUCTION EQUIPMENT

With the present volume and the limited number of people in the operation, automation of the various activities does not appear practical. Additionally, it should be noted that many of the activities, which individually do not have a large number of operators, are manually controlled because the operation changes each time the job is done, due to the shape, size, weight and consistency of the base product piece. With the low volume of through put requirements of the meat plant, the only real justification is reduction of scrap, and the AAFES meat plant has a very low scrap rate to begin with, so there is little to be saved.

5.4.4 IMPROVE LAYOUT AND SPACE UTILIZATION

In order to improve the space layout of the meat plant, additional space would be required. The resultant improvement would benefit the operation, but, decrease the activity to space ratio which is currently slightly cramped. The current study on the new frozen goods storage warehouse could have an impact on the meat plant and provide some space which could be used to improve and ease the flow of product.

5.4.5 CONSOLIDATION OF REQUIRED SPECIAL ENVIRONMENTS

The discussion under this heading is a duplicate of the discussion under the same heading in the "Ice Cream Plant" section of this report. Namely, the ice cream plant and the meat plant have similarities of environments required, but the practicality of combining these operations is questionable. Within the meat plant operation, the possible combinations have already been achieved.

5.4.6 PRODUCTION EQUIPMENT MAINTENANCE

A Preventive Maintenance program is in effect for the meat plant. The program is manually controlled and operated. It is very successful as shown by the fact that a major malfunction has not caused a protracted down period of meat plant operations in the past several years. The current project to modify existing software and automate the Preventive Maintenance program, through the use of a personal computer, will enhance the system and allow greater historical tracking as well as improve the scheduling of the preventive maintenance activities.

5.4.7 IMPROVE METHODS AND CONTROLS

The opportunity to improve methods and controls in the meat plant is limited. Because of the low volume, highly automated equipment is not practical and can not be justified. There is very little disposed of scrap created in the meat plant which eliminates the possibility of automation to reduce scrap. In general, the potential of any automation would be to automate operations for increased volume requirements, with the same number of operators.

5.4.8 ZONE EXISTING MULTIPLE USE FACILITIES

As with the ice cream plant, the meat plant is already zoned into the process room activities and the storage activities. Any further zoning of this operation would simply be an impediment to orderly flow. Within the various areas of activity (eg. Grinding, Slicing etc.) further wall installations would hamper the operation.

5.4.9 RESCHEDULE UTILIZATION OF EXISTING FACILITIES

The only rescheduling of utilization of the existing facility would be the elimination of the activity in total and buy all meat products pre-processed. This is not practical from a cost and operational stand point, as it would also cut out profits which the troops eventually benefit from, there by evading the mission of AAFES. The meat plant only operates on a one shift basis, however, the potential of the area being used for other activities during the off shifts is not practical due to sanitation reasons.

5.4.10 CONSOLIDATE SERVICES INTO PERMANENT BUILDINGS

The meat plant is already in a permanent building. Consolidation of other activities into the meat plant space is not practical due to food sanitation requirements with meat, and the fact that there does not exist a large area of wasted space. The potential of having a new frozen goods storage warehouse would allow the consolidation of some outside storage and the improvement of storage facilities and practices in current storage areas.

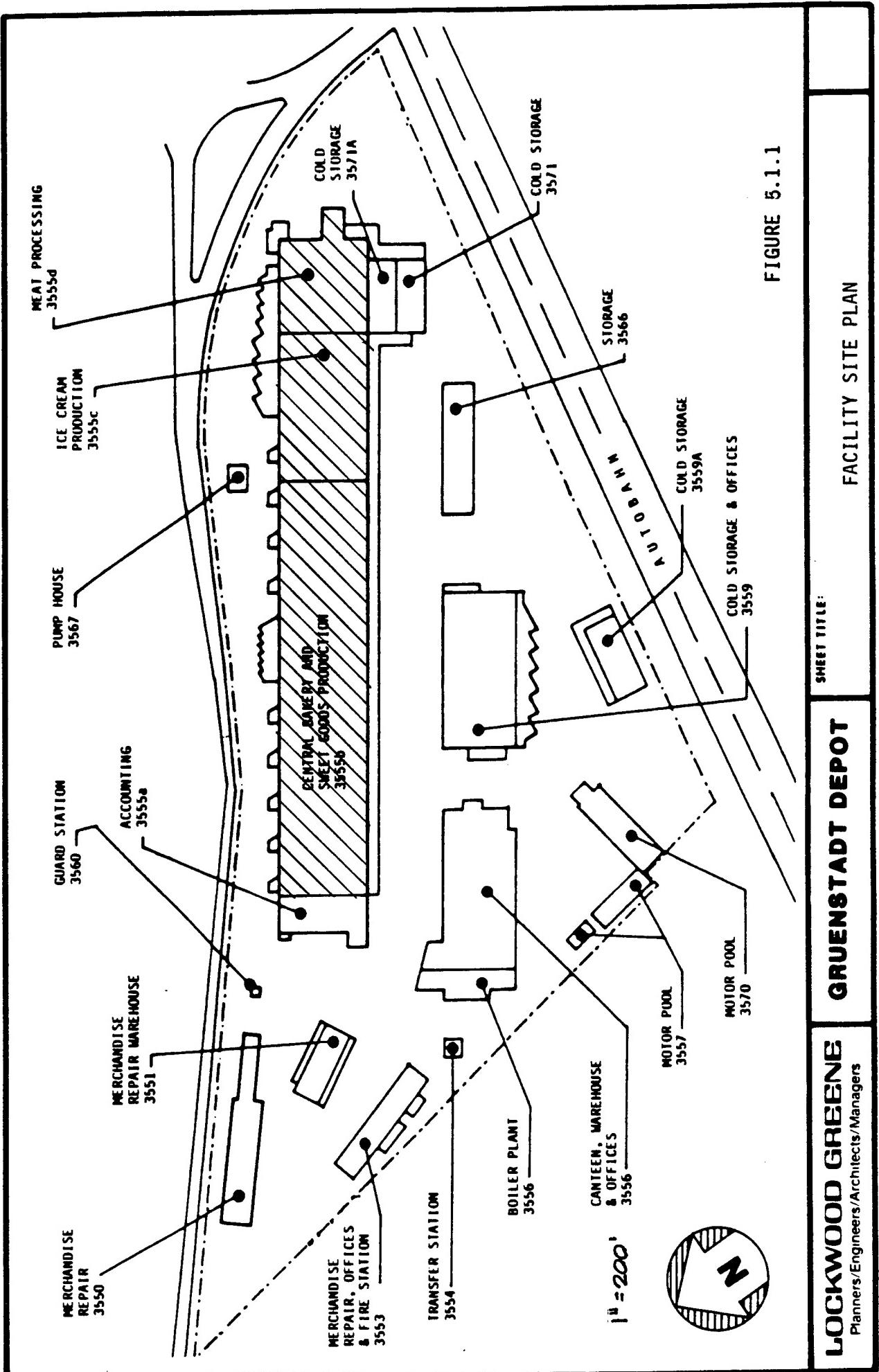
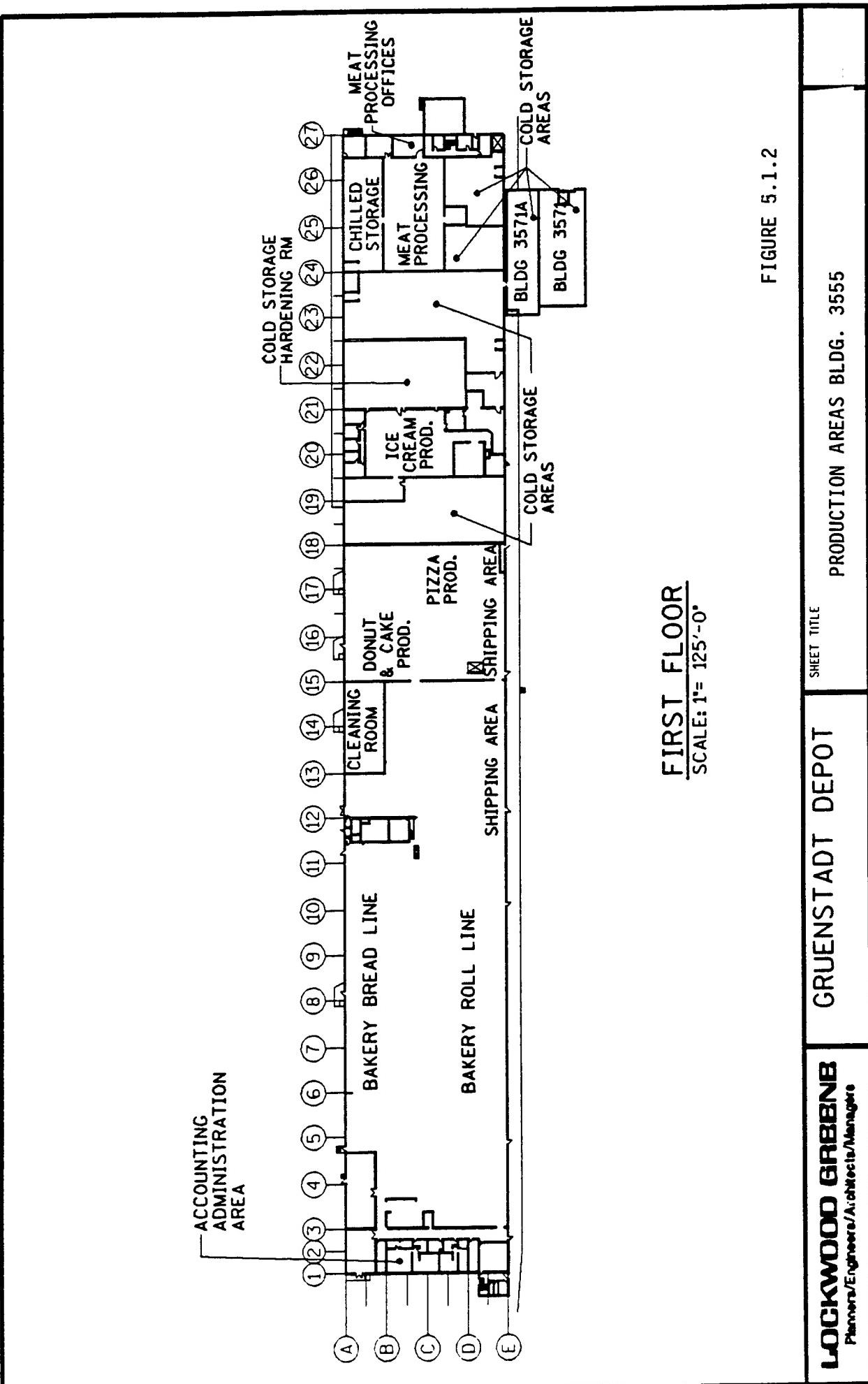


FIGURE 5.1.1



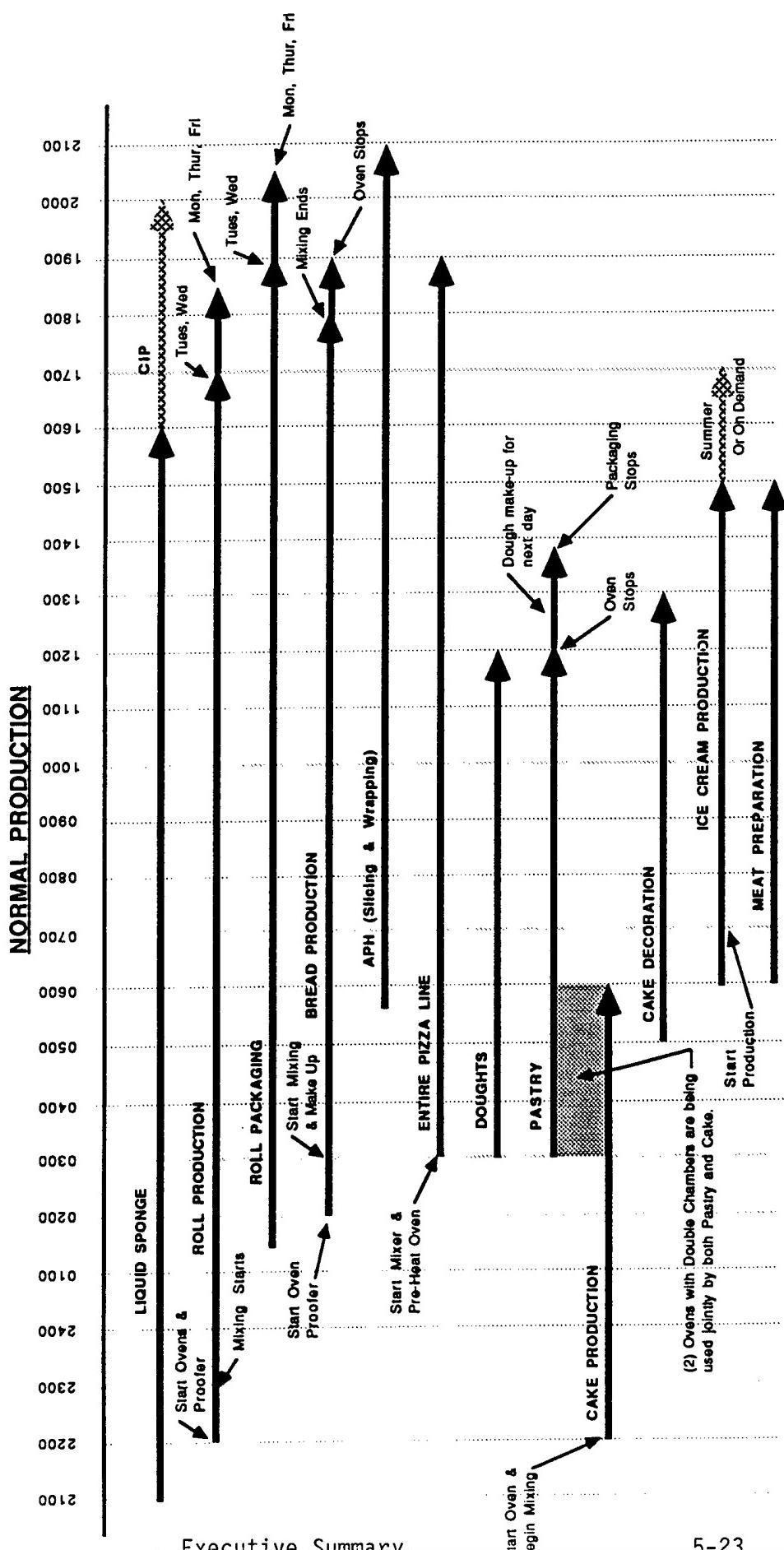


Figure 5.1.3

**Building 3555
PRODUCTION SCHEDULE**

Table 5.1.4 - October 1988
Monthly Labor Summary
Production Operators

Plant	Payroll Operators	% of Total
Bakery	154	71.3
Meat	23	10.6
Ice Cream	<u>39</u>	18.1
Total	216	

Figure 5.1.5
AAFES Gruenstadt
Operators Per Payroll Data

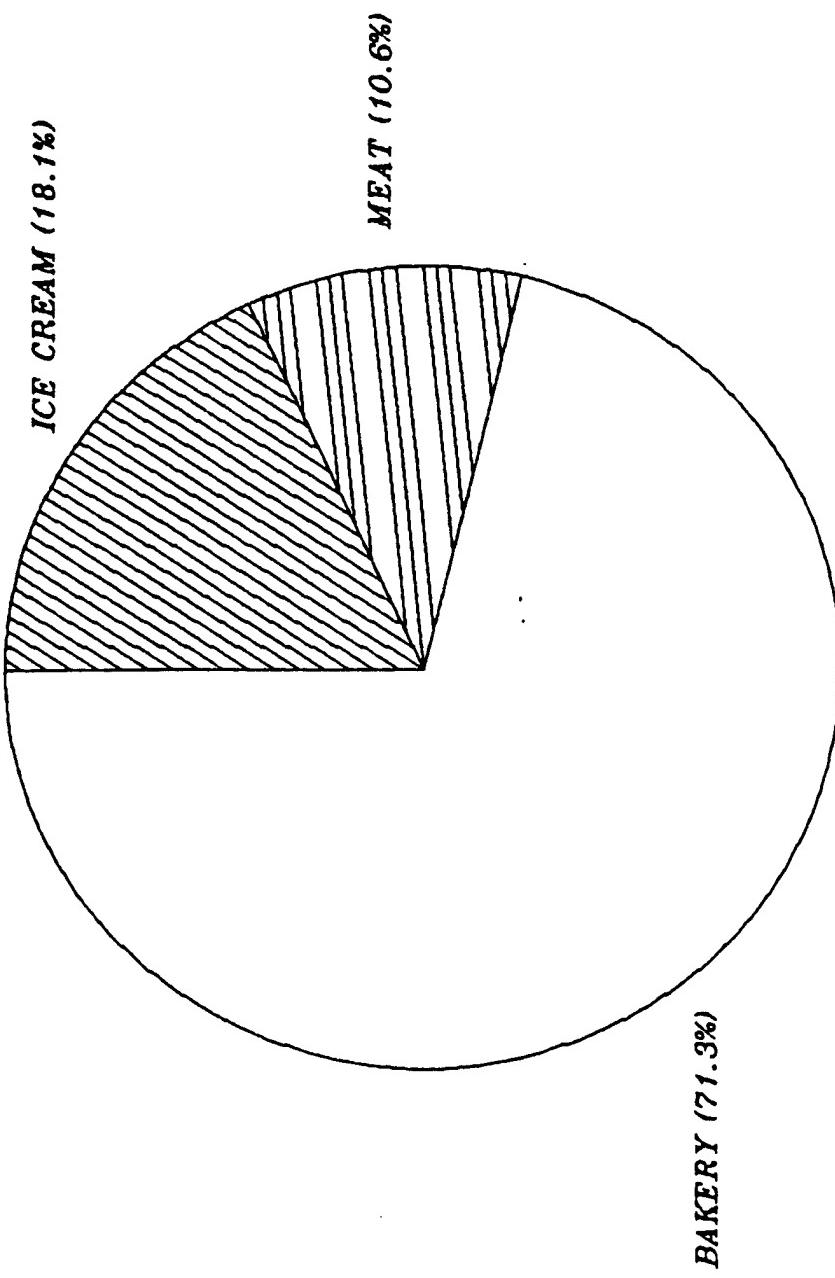


Table 5.2.1
ROLL LINE CAPACITIES & LIMITATIONS
PACKAGES PER MINUTE

AFFES Bakery, Greenstadt
 November 1968

Print: HS/16 7/70
 File: RLNCAP

No.	Description	Unit	WEIGHT - oz. Scale	PAN SIZES	MIXING	DIVIDER	ROUNDER	PROOFER	MULDER	IPROOF BOX	OVEN	COOLER	Slicers	BAGGERS	LIMITER	MAXIMUM PK's	
[202] Hamburger	8 Pk	16.0	13.0	31.5625 29.3000	'6.3125 19.7500	32	88.0	100.0	100.0	166.0	128.0	104	119	119	Mixing	88.0	
[205] Frankfurter	8 Pk	16.0	13.0	31.5625 29.3000	'6.3125 19.7500	32	88.0	100.0	100.0	145.0	112.0	114	119	119	Mixing	88.0	
[20] Jumbo (PP)	6 Pk	18.0	15.0	31.8125 21.5000	21.5000	24	78.0	133.0	133.0	133.0	124.0	96.0	104	119	119	Mixing	78.0
[231] Jumbo (PP)	20 Pk	60.0	52.5	31.8125 21.5000	21.5000	24	23.3	40.0	40.0	40.0	37.4	28.8	31	27	27	Mixing	23.3
[23] BK Whopper (PP)	20 Pk	56.7	50.0	31.8125 21.5000	21.5000	24	24.8	40.0	40.0	40.0	37.4	28.8	31	27	27	Mixing	24.0
[223] BK Special Sand (PP)	24 Pk	74.0	66.7	29.7500 21.3750	21.3750	24	19.0	33.0	33.0	33.0	20.0	16.0	27	27	27	Oven	16.0
[233] Steak Rolls (PP)	24 Pk	74.0	66.7	29.7500 21.3750	21.3750	24	19.0	33.0	33.0	33.0	20.0	16.0	27	27	27	Oven	16.0
[222] BK Indy 4" Hamb (PP)	30 Pk	67.5	50.0	28.2000 29.3000	19.7500	24	20.0	26.0	26.0	26.0	22.0	22.0	22	27	27	Mixing	20.0
[232] Indy 4" Hamb (PP)	30 Pk	67.5	60.0	29.3000	19.7500	24	20.0	26.0	26.0	26.0	29.0	22.0	22	27	27	Mixing	20.0
[213] Diner	18 Pk	13.5	12.0	22.3075 3.3437	3.3437	3	104.0	66.0	66.0	66.0	218.0	168.0	106	-	-	Divider	66.0
[214] Diner	18 Pk	13.5	12.0	22.3075 3.3437	3.3437	3	104.0	66.0	66.0	66.0	218.0	168.0	106	-	-	Divider	66.0
[207] Submarine	6 Pk	24.0	20.0	21.2500 21.3750	19.3125	10	58.0	12.5	12.5	12.5	109.0	48.0	89	-	-	Divider	12.5
[208] Hoagie	6 Pk	15.0	12.5	29.7500 21.3750	21.3750	24	93.0	16.6	16.6	16.6	124.0	54.0	111	-	-	Divider	16.6

NOTES:

1. (PP) after product in description column means 2nd row back
2. BK in description column means Burger King
3. Items 213, 214, 201 and 208 are not sliced

Table 5.2.2

Month	Production Issued Millions of Pounds
November 1987	3.6
December	3.5
January 1988	3.3
February	3.7
March	3.7
April	3.5
May	3.7
June	3.7
July	3.2
August	3.1
September	3.6
October	3.3
TOTAL 12 MONTHS	<u>41.9</u>
MONTHLY AVERAGE	3.5

ACTUAL APRIL 1988 BAKERY UNITS ISSUED

AAFES Bakery, Gruenstadt

Prod No	Description	Unit	Apr '88 Act Units	Apr '88 Dly Avg	Daily Hours	Units Per Minute
101	Sandwich Bread	ea	628,455	29,926.4		
102	Family Bread	ea	79,249	3,773.8		
110	Texas Style Bread	ea	49,267	2,346.0		
103	Wheat Bread R T	ea	171,962	8,189.6		
105	Amer Rye Bread R T	ea	40,490	1,928.1		
107	Raisin Bread R T	ea	23,008	1,095.6		
109	French Bread	ea	36,506	1,738.4		
111	Super Deli French Bread	ea	9,341	444.8		
131	C H Split White Bread	ea	299,959	14,283.8		
132	C H Split Wheat Bread	ea	137,021	6,524.8		
133	C H 7-Whole Grain Bread	ea	34,696	1,652.2		
134	C H Buttermilk	ea	42,344	2,016.4		
TOTAL BREAD			1,552,318	73,919.9	14	88.00
201	Jumbo Hamber Buns	Pk6	53,772	2,560.6		
202	Hamburger Buns	Pk8	229,533	10,930.1		
205	Frankfurter Rolls	Pk8	220,253	10,488.2		
206	Submarine Rolls	Pk6	10,839	516.1		
213	Dinner Rolls	Pk18	24,026	1,144.1		
214	Dinner Rolls B&S	Pk18	24,411	1,162.4		
215	Seeded Steak Rolls	Pk6	8,794	418.8		
221	Jumbo Hamburger Buns	Pk20	15,496	737.9		
222	Hamburger Buns	PK30	46,007	2,190.8		
231	Whopper Kaiser Cit	Pk20	18,837	897.0		
233	Special Rolls	Pk24	10,129	482.3		
240	C H Whole Grain NH Dinner	Pk18	4,579	218.0		
241	English Muffin	Pk6	14,138	673.2		
242	Cinnamon Muffin	Pk6	10,818	515.1		
TOTAL ROLLS			691,632	32,934.9	21	26.14
301	Glazed Donuts	Pk6	40,003	1,904.9		
302	Glazed Donuts	Pk12	6,740	321.0		
303	Jelly Donuts	ea	13,745	654.5		
304	Jelly Donuts	Pk5	11,536	549.3		
305	Jelly Donuts	Pk12	1,830	87.1		
401	Plain Cake Donuts	Pk2	26,950	1,283.3		
403	Sug Cake Donuts	Pk2	54,251	2,583.4		
404	Cinn Cake Donuts	Pk2	28,608	1,362.3		
405	Del Iced Cake Donuts	Pk2	51,608	2,457.5		
406	Plain Cake Donuts	Pk6	15,743	749.7		
408	Sug Cake Donuts	Pk6	21,496	1,023.6		
409	Cinn Cake Donuts	Pk6	11,017	524.6		
410	Van Iced Cake Donuts	Pk6	4,511	214.8		
411	Plain Cake Donuts	Pk12	2,878	137.0		
412	Sug Cake Donuts	Pk12	5,240	249.5		

(Page 2 of 3)

Table 5.2.3 (continued)

ACTUAL APRIL 1988 BAKERY UNITS ISSUED

AAFES Bakery, Gruenstadt

Prod No	Description	Unit	Apr '88 Act Units	Apr '88 Dly Avg	Daily Hours	Units Per Minute
413	Cinn Cake Donuts	Pk12	2,708	129.0		
416	Choc Iced Cake Donuts	Pk12	2,164	103.0		
417	Van Iced Cake Donuts	Pk12	1,448	69.0		
418	Choc Iced Cake Donuts	Pk6	4,135	196.9		
	TOTAL DONUTS		306,611	14,600.5	7	34.76
516	Apple Turnovers	Pk4	8,848	421.3		
512	Blueberry Turnovers	Pk4	3,567	169.9		
513	Cherry Turnovers	Pk4	4,563	217.3		
	TOTAL TURNOVERS & PIES		16,978	808.5	7	1.92
603	Plain Pound Cake	ea	3,973	189.2		
605	Angel Food Cake	ea	1,927	91.8		
606	Coconut Jelly Roll	ea	2,446	116.5		
612	Gourm Dutch Apple Cake	ea	2,489	118.5		
613	Coconut Jelly Roll SL	ea	15,103	719.2		
615	Iced Choc Cake 1/2 SH	ea	51	2.4		
616	Iced Gold Cake 1/2 SH	ea	44	2.1		
614	Cherry Cheese	ea	3,914	186.4		
652	Choc Fudge Brownies	ea	22,983	1,094.4		
	TOTAL CAKES REGULAR		52,930	2,520.5	14	3.00
706	Cinnamon Buns	Pk6	6,361	302.9		
711	Gourm Cheese Apple Cake	ea	3,526	167.9		
722	Danish Alm Nut Ring	ea	3,852	183.4		
723	Del German Nut Ring	ea	1,391	66.2		
736	Fruit Filled Cheese Dan	Pk4	7,607	362.2		
742	Cheese Dan Blueberry	ea	35,502	1,690.6		
743	Cheese Dan Apple	ea	57,231	2,725.3		
744	Cheese Dan Cherry	ea	53,367	2,541.3		
745	Cheese Dan Pineapple	ea	32,455	1,545.5		
771	Honey Bun	ea	10,700	509.5		
772	Honey Buns	Pk6	3,122	148.7		
773	Pecan Rolls	Pk8	8,337	397.0		
	TOTAL PASTRY		223,451	10,640.5	7	25.33
808	Grand Opening Cake	ea	50	2.4		
820	Heart Cake	ea	86	4.1		
821	1/4 Sheet Cake	ea	493	23.5		
822	1/2 Sheet Cake	ea	964	45.9		
830	Heart Cake H Anniversary	ea	372	17.7		
831	1/4 Sh Cake H Anniversary	ea	1,236	58.9		
832	1/4 Sh Cake Holiday	ea	2,481	118.1		
833	Heart Cake Holiday	ea	1,634	77.8		

(Page 3 of 3)

Table 5.2.3 (continued)

ACTUAL APRIL 1988 BAKERY UNITS ISSUED

AAFES Bakery, Gruenstadt

Prod No	Description	Unit	Apr '88 Act Units	Apr '88 Dly Avg	Daily Hours	Units Per Minute
834	1/4 Sh Cake Cuddle Bear	ea	314	15.0		
835	1/4 Sh Cake Doggy Face	ea	317	15.1		
836	1/4 Sh Cake Clown Face	ea	336	16.0		
837	Heart Cake Rainbow	ea	229	10.9		
847	Baby Rattle Cake	ea	57	2.7		
839	1/4 Sh Cake JackInTheBox	ea	88	4.2		
840	1/4 Sh Cake Robot	ea	91	4.3		
841	1/4 Sh Cake Balloon	ea	189	9.0		
846	Special Cakes	ea	361	17.2		
TOTAL DECR. CAKES			9,298	442.8	14	0.53
850	Heart Cake Chocolate	ea	60	2.9		
851	1/4 Sh Cake Chocolate	ea	112	5.3		
853	Heart Cake Gold	ea	60	2.9		
855	1/2 Sh Cake Gold	ea	40	1.9		
TOTAL UN-DECR. CAKES			272	13.0	7	0.03
901	9" Pizza Crust	Pk6	11,611	552.9		
902	12" Pizza Crust	Pk3	14,906	709.8		
913	12" Pizza Crust Bulk	Pk15	8,008	381.3		
915	16" Pizza Crust Bulk	Pk15	8,788	418.5		
TOTAL PIZZA CRUSTS			43,313	2,062.5	14	2.46

Table 5.2.4
BREAD LINE CAPACITIES & LIMITATIONS
LOAVES PER MINUTE

A&F3 Bakery, Greenstadt
 November 1988

Print: 11/16/77/79
 File: BLMCAP

No.	Description	Unit	WEIGHT - oz. Scale	Batch	PAN SIZES	MIXING	DIVIDER	ROUNDER	PROOFER	Moulder	PROOF BOX	OVEN	COOLER	SPLICERS	BAGGERS	LIMITER	MAXIMUM LPM	
101	Pullman	ea	27.5	24.3	30.3750	13.5625	6	155	360	224	216	18*	19C	207	204	Mixing	155	
102	Fatty	ea	18.3	16.3	31.3025	10.4375	5	237	360	224	213	252	25	207	204	Slicing	204	
103	Wheat	ea	18.3	16.3	31.3025	10.4375	6	237	360	224	213	252	254	207	204	Slicing	204	
105	American Rye	ea	18.3	16.3	29.3750	10.5300	4	237	360	224	213	274	153	207	204	Cooler	151	
107	Raisin	ea	18.3	16.3	31.0625	10.4375	5	237	360	224	213	262	24*	207	30	Slicer	30	
109	French	ea	16.3	2.3	29.3750	17.5250	7	204	360	224	210	189	173	(A)	30	Packing	90	
110	Texas Toast	ea	27.5	24.3	30.3750	13.5625	5	155	360	224	210	18*	19C	207	204	Mixing	155	
111	Super French	ea	26.3	23.5	26.3125	10.3000	4	164	260	163	213	213	07	39	(A)	-	Packing	60
131	C.H. White Split Top	ea	27.5	24.3	29.7500	14.3625	5	155	360	360	224	213	134	13C	186	204	Oven	130
132	C.H. Wheat Split Top	ea	27.5	24.3	29.7500	14.3625	5	155	360	360	224	213	134	13C	186	204	Oven	130
133	C.H. 7 Grain	ea	22.5	20.3	31.0625	10.4375	6	165	360	224	210	221	204	204	204	Mixing	185	

NOTES:

- (A) Racked off for cooling, not sliced, and packed by hand.

Table 5.2.5
BREAD LINE MAKE-UP/BAKING IDEAL MANNING

AAFES Bakery, Gruenstadt
November 1988

No.	Job Description	NUMBER OF OPERATORS			TOTAL OPER.
		Shift 1	Shift 2	Shift 3	
1	Ingredient Scaler	1	1	-	2
2	Liquid Sponge	1	1	1	3
3	Dough Mixer	1	1	-	2
4	Dough Mixer Helper	1	1	-	2
5	Divide Operator	1	1	-	2
6	Make-up/Pan-O-Mat	2	2	-	4
7	Oven Tenders	2	2	-	4
8	Pan Stacker/Unstacker	2	2	-	4
9	Lidder Operator	1	-	-	1
10	Supervisor	1	1	-	2
11	Foreman	1	1	-	2
TOTALS		14	13	1	28

Table 5.2.6
BREAD LINE PACKAGING IDEAL MANNING

AAFES Bakery, Gruenstadt
November 1988

No.	Job Description	NUMBER OF OPERATORS			TOTAL OPER.
		Shift 1	Shift 2	Shift 3	
1	Packaging Machine Oper.	3	3	-	6
2	Helper	1	1	-	2
3	Basket Loading Monitor	1	1	-	2
4	Basket Unstacker	1	1	-	2
5	Basket Stacker	1	1	-	2
6	Supervisor	1	1	-	2
7	Foreman	1	1	-	2
TOTALS		9	9	0	18

Table 5.2.7 - BREAD LINE
ACTUAL OPERATORS REQUIRED vs. PAYROLL OPERATORS

	Make-Up/ Baking	Packaging	Total
Ideal Required	28	18	46
Vacation Coverage	4	3	7
7.6% Absentees	3	2	5
--	--	--	--
Total Required	35	23	58
Total Actual			52
Difference			-6

Table 5.2.8

ROLL LINE MAKE-UP/BAKING IDEAL MANNING

*AAFES Bakery, Gruenstadt
November 1988*

Table 2.2.8

No.	Job Description	NUMBER OF OPERATORS			TOTAL OPER.
		Shift 1	Shift 2	Shift 3	
1	Scaler	1.0	1.0	-	2.0
2	Dough Mixer	1.0	1.0	0.5	2.5
3	Divider Operator	1.0	1.0	0.5	2.5
4	Laborer	1.0	2.0	1.0	4.0
5	Pan Stacker/Unstacker	1.0	2.0	1.0	4.0
6	Oven Tender	1.0	2.0	1.0	4.0
7	Supervisor	1.0	1.0	-	2.0
8	Foreman	1.0	1.0	-	2.0
TOTALS		8.0	11.0	4.0	23.0

Table 5.2.9

ROLL LINE PACKAGING IDEAL MANNING

*AAFES Bakery, Gruenstadt
November 1988*

Table 2.2.9

No.	Job Description	NUMBER OF OPERATORS			TOTAL OPER.
		Shift 1	Shift 2	Shift 3	
1	Packaging Machine Oper.	1.0	2.0	2.0	5.0
2	Laborer	3.0	5.0	5.0	13.0
3	Foreman	1.0	1.0	1.0	3.0
TOTALS		5.0	8.0	8.0	21.0

Table 5.2.10 - ROLL LINE
ACTUAL OPERATORS REQUIRED vs. PAYROLL OPERATORS

	Make-Up/ Baking	Packaging	Total
Ideal Required	23	21	44
Vacation Coverage	3	3	6
7.6% Absentees	3	2	5
--	--	--	--
Total Required	29	26	55
Total Actual			46
Difference			-9

Table 5.2.11 - DONUTS, SWEET GOODS, CAKES & PIZZA
ACTUAL OPERATORS REQUIRED vs. PAYROLL OPERATORS

	Make-Up	Packaging	Total
Ideal Required	32	20	52
Vacation Coverage	4	3	7
7.6% Absentees	2	2	4
	--	--	--
Total Required	38	25	63
Total Actual			56
Difference			-7

Table 5.2.12
DONUTS, SWEET GOODS, CAKES & PIZZA MAKE-UP MANNING

AAFES Bakery, Gruenstadt
November 1988

No.	Job Description	NUMBER OF OPERATORS			TOTAL OPER.
		Shift 1	Shift 2	Shift 3	
DONUTS					
1	Foreman	1	-	-	1
2	Mixer	1	-	-	1
3	Icer	1	-	-	1
4	Frier	1	-	-	1
Sub-Total Donuts		4	0	0	4
SWEET GOODS					
1	Foreman	1	-	-	1
2	Table Foreman	1	-	-	1
3	Mixer	1	-	-	1
4	Oven	1	-	-	1
5	Table Operators	4	-	-	4
6	Icers	2	-	-	2
7	Roll In	4	-	-	4
Sub-Total Sweet Goods		14	0	0	14
CAKES					
1	Foreman/Decorator	1	-	-	1
2	Decorators	3	-	-	3
3	Helper	1	-	-	1
4	Layer Making	-	3	-	3
Sub-Total Cakes		5	3	0	8
PIZZA					
1	Foreman	1	1	-	2
2	Mixer	1	1	-	2
3	Sheeter	1	1	-	2
Sub-Total Pizza		3	3	0	6
GRAND TOTAL MAKE-UP		26	6	0	32

Table 5.2.13

DONUTS, SWEET GOODS, CAKES & PIZZA PACKAGING MANNING

AAFES Bakery, Gruenstadt
November 1988

No.	Job Description	NUMBER OF OPERATORS			TOTAL OPER.
		Shift 1	Shift 2	Shift 3	
DONUTS					
1	Foreman	1	-	-	1
2	Hand Packers	4	-	-	4
3	Mustang Oper.	2	-	-	2
4	Scotty Oper.	2	-	-	2
Sub-Total Donuts		9	0	0	9
SWEET GOODS					
1	Foreman	1	-	-	1
2	Pastry Packers	2	-	-	2
3	Wrapper/Labeler	1	-	-	1
Sub-Total Sweet Goods		4	0	0	4
CAKES					
1	Cake Packers	3	-	-	3
Sub-Total Cakes		3	0	0	3
PIZZA					
1	Wrappers	2	2	-	4
Sub-Total Pizza		2	2	0	4
GRAND TOTAL MAKE-UP		18	2	0	20

Table 5.3.1

ICE CREAM PLANT CAPACITIES & LIMITATIONS
PIECES PER MINUTE

AAFES Ice Cream Plant, Gruenstadt
 November 1988

Print: HS/16.7/TQ
 File: ICPLCAP

Description	MIXING COOLING	Other	FREEZING Ch. Bur.	Crepaco	FILLING	WRAPPING	LIMITER	MAXIMUM Units/Min
1/2 Gallon	40.0			40	30	Manual	Filling	30
Pints	160.0		20.0		26	48	Freezing	20
Cubs 5 oz	512.0		64.0		80	48	Wrapping	48
Vitafine Popsicles 2.5 oz	170.6	128.0			160	30	Wrapping	30
Fudgesicles 2.5 oz	170.5	128.0			144	30	Wrapping	30
Frosticks 2.5 oz	170.5	128.0			144	30	Wrapping	30
Creamsticks 2.5 oz	170.5	128.0			112	30	Wrapping	30
Drumsticks 2.5 oz	170.5	128.0			55	25	Wrapping	25
Sandwiches 3.0 oz	182.2	115.4			50	25	Wrapping	25
Snocone (6 gallons bulk)	-	-			30	-	Filling	30

Table 5.3.2
ICE CREAM PLANT MANNING

*AAFES Ice Cream Plant, Gruenstadt
 November 1988*

Line	Freezer Oper.	Package Machine Oper.	Pack Off	Utility	TOTAL
Bulk	1	-	2	-	3
Half Gallon	1	1	2	1	5
Pints	1	1	1	1	4
Cups	1	1	2	-	4
Drumsticks	1	1	2	-	4
Sandwiches	1	1	2	-	4
Vitaline	1	1	3	1	6
Soft Serve/Shake	-	1	1	-	2
TOTALS	7	7	15	3	32

Figure 5.3.3
PRODUCTIVITY
EIA, ICE CREAM PLANT
1988

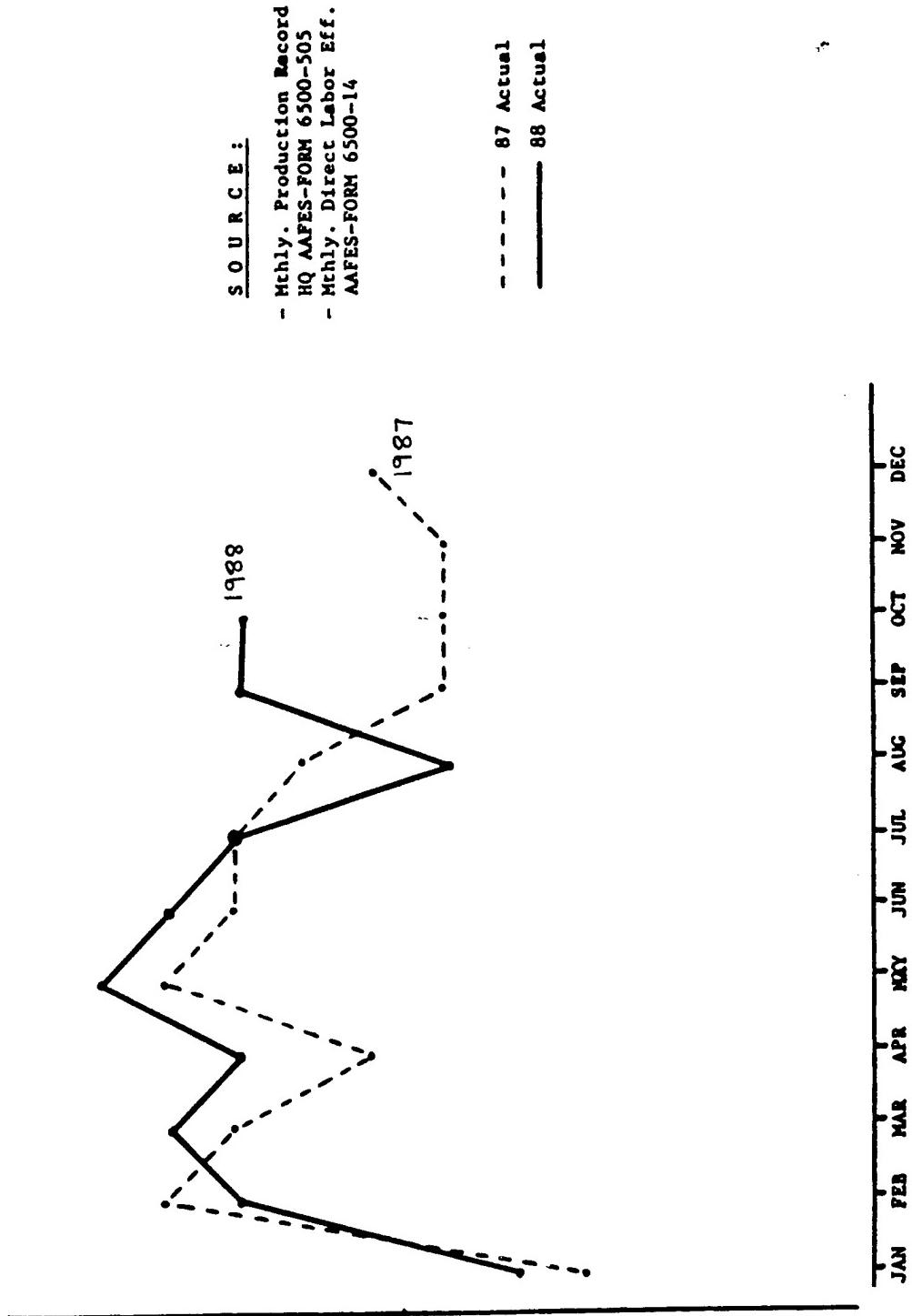
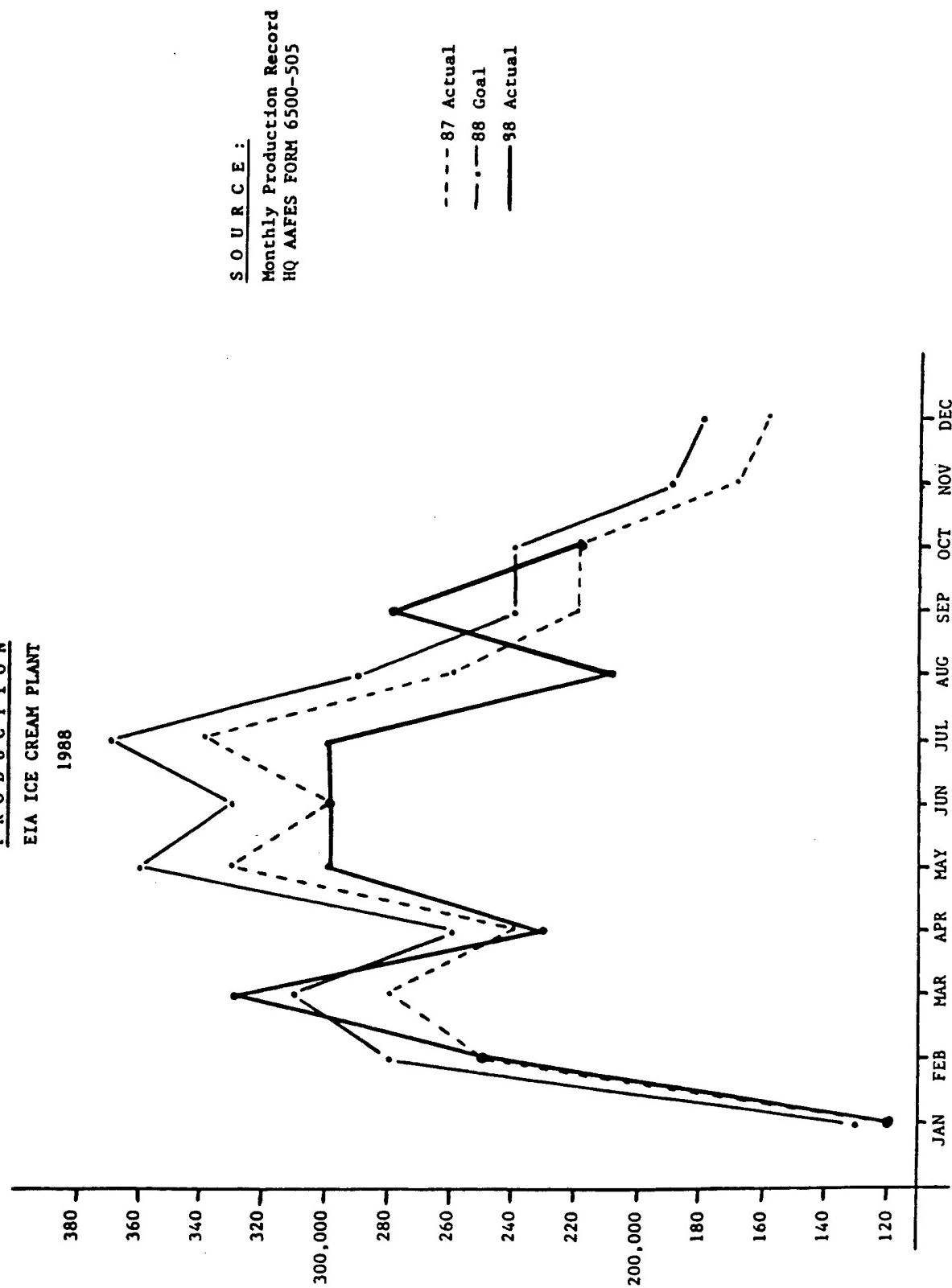


Figure 5.3.4
PRODUCTION
EIA ICE CREAM PLANT
1988



(Page 1 of 2)

Table 5.4.1
MEAT PLANT CAPACITIES & LIMITATIONS
POUNDS PER HOUR

AAFES Meat Plant, Gruenstadt
 November 1988

Print: HS/18.7/T0
 File: MTPLCAP

Product	BLOCK GRINDER	MIXER/ BOWL	FORMAX/ STUFFER	SLICING	MANUAL FUNCTIONS	PACKING	LIMITER	MAXIMUM Lbs/Hr
Ground Beef Lean Bulk 1 lb	15,000	825	3,996			2,500	Mixer	825.00
Ground Beef Bulk 1 lb	15,000	4,050	3,996			2,500	Formax	3996.30
Hamburger Patties 3 oz	15,000	4,050	2,700			4,300	Formax	2700.00
Hamburger Patties 4 oz	15,000	4,050	3,300			4,300	Formax	3000.30
Hamburger Patties 5 1/3 oz	15,000	4,050	3,996			4,300	Formax	3996.00
Hamburger Patties 8 oz	15,000	4,050	3,960			4,300	Formax	3960.00
Ground Beef Patties 4-3 oz	15,000	4,050	2,700			2,500	Packing	2500.00
Meat Loaf 5 lbs	15,000	825	650			2,000	Stuffer	650.00
Meat Loaf 2 lbs	15,000	825	325			1,200	Stuffer	325.00
Saltisbury Steak	15,000	825	1,200			4,300	Mixer	925.00
Festiy Pack	15,000	4,050	3,000			2,500	Packing	2500.00
Ground Beef Bulk 24 lbs	15,000	4,050	3,960			4,300	Formax	3960.00
Bacon 8 oz Retail				1,950		900	Packing	900.00
Pork Shoulder 8 oz Retail				1,800		1,300	Packing	1800.00
Bologna 8 oz Retail				1,800		1,300	Packing	1800.00
Hard Salami 8 oz Retail				900		900	Packing	900.00
Cooked Salami 8 oz Retail				1,800		1,800	Packing	1800.00
Bacon 1/2 oz Retail				1,350		1,350	Packing	1350.00
Bacon 40 lbs box Food				1,950		(A)2,000	Slicing	1950.00
Bologna 16 oz Food				1,800		3,500	Slicing	1800.00
Pork Shoulder 15 oz Food				1,350		3,275	Slicing	1350.00
Ham Steak 15 oz Food				4,500		3,275	Packing	3375.00
Ham Steak 16 oz Food				7,200		3,500	Packing	3600.00
Cooked Salami 16 oz Food				1,800		1,300	Packing	1800.00
Minute Steak Retail					117.30		Manual	117.30
Cube Steak Retail					124.20		Manual	124.20
Round Steak Retail					120.75		Manual	120.75
Swiss Steak Retail					134.55		Manual	134.55
Breakfast Steak Food					165.66		Manual	165.66
Cube Steak Food					87.96		Manual	87.96
Round Steak Food					134.55		Manual	134.55
T-Bone 16 oz					499.30		Manual	499.00
Cube 8 oz					499.00		Manual	499.00
T-Bone 14 oz					220.20		Manual	220.20
T-Bone 16 oz Food					499.00		Manual	499.00
T-Bone 12 oz Food					374.25		Manual	374.25
Club 8 oz Food					280.50		Manual	280.50
New York Steak 8 oz					310.34		Manual	310.34
New York Steak 11 oz					426.72		Manual	426.72
New York Steak 11 oz Food					426.72		Manual	426.72
New York Steak 16 oz Food					620.70		Manual	620.70
New York Steak 8 oz Food					310.34		Manual	310.34
Steakin Steak 16 oz					399.99		Manual	399.99

(Page 2 of 2)

Table 5.4.1 (continued)

MEAT PLANT CAPACITIES & LIMITATIONS

POUNDS PER HOUR

AMFES Meat Plant, Gruenstadt
November 1988

Print: HS/16.7/TQ
File: NTPLCAP

Product	BLOCK GRINDER	MIXER/ BOWL	FORMAX/ STUFFER	SLICING	MANUAL FUNCTIONS	PACKING	LIMITER	MAXIMUM Lbs/Hr
Sirloin Steak 2 oz Food					299.99	Manual	299.99	
Sirloin Steak 3 oz Food					199.99	Manual	199.99	
Tenderloin Steak 8 oz Food					225.00	Manual	225.00	
Pork Chops					338.00	Manual	338.00	
Pork Chops 4 oz Food					480.00	Manual	480.00	
Spare Ribs 2-3 lbs					923.00	Manual	923.00	
Stewing Beef						By Product		
Stewing Beef Food						By Product		
Luncheon Steak Food						By Product		
Bacon Ends Food						By Product		
Nam for Salad Food						By Product		
Boagna Ends Food						By Product		
Hard Salami Ends Food						By Product		
Cooked Salami Ends Food						By Product		

NOTES:

(A) Packed manually

MEAT PLANT CREAMING SET-UPS
AATPS Meat Plant, Grunstadt
November 1968

Area	Deboning/ Prepare	P. Grind/ Ch. Bowl	Form./ Stuff.	Slice	Weigh & Assemb.	Mach. Oper.	Portion.	Packers	Weigh & Pack	Utility	TOTALS
Grinding	1 - 3	1 - 3	1 - 2	-	2 - 6	0 - 1	-	-	1 - 4	1 - 4	10 - 18
Slicing	3 - 4	-	-	1 - 3	-	-	1 - 2	-	-	0 - 3	9 - 15
Rounds	1	-	-	-	-	-	1 - 2	-	-	-	7
Shortloins	1	-	-	-	-	-	2 - 3	-	-	-	7
Striploins	1	-	-	-	-	-	0 - 1	-	-	-	7
Pork	1 - 2	-	-	-	-	-	-	-	-	2 - 5	4 - 7
By Products	-	-	-	-	-	-	-	-	-	1	1

NOTE:
 Above chart shows the range of operators required for the various activities within an area.
 The range of operators required is dictated by the particular product being processed. The figures are not additive.

SECTION 6

ENERGY CONSERVATION ANALYSIS

- 6.1 LIST OF ALL ECO's
- 6.2 LOW COST/NO COST PROJECTS

6.1 LIST OF ALL ECO'S

Table 6.1.1 lists all ECO's which have been evaluated for potential energy savings. This table includes both economically feasible and non-feasible ECO's. The table includes ECO title and number, simple payback, project cost (\$), savings to investment ratio (SIR), annual savings (\$) and funding recommendations.

ECO's listed on Table 6.1.1 with a funding category of "NONE" were found to economically non-feasible (SIR less than 1 or payback less than 8 years), technically unfeasible, or were already being implemented under a previous study. Refer to Section 7 of the Energy Analysis Report for technical reasons why some ECO's were deemed non-feasible.

Refer to Section 8 for a prioritized list of ECO's recommended and a description of the project funding criteria.

6.2 LOW COST/NO COST PROJECTS

The following table contains some projects which have negligible or no initial cost, and which can be implemented immediately with facility personnel, to reduce annual utility and maintenance costs.

<u>Project</u>	<u>Applicable Buildings</u>					
	<u>3555a</u>	<u>3555b</u>	<u>3555c</u>	<u>3555d</u>	<u>3556</u>	<u>3559</u>
Building Construction:						
1. Replace torn plastic curtains in cold storage areas.				X	X	X
2. Caulk and weatherstrip all ingress/egress doors and windows.		X	X	X	X	X
Mechanical:						
3. Replace the domestic hot water mixing valve serving Building 3555a, to maintain constant 105°F domestic hot water. Mixing valve as surveyed was broken and could not be adjusted.			X			

<u>Project</u>	<u>Applicable Buildings</u>					
	<u>3555a</u>	<u>3555b</u>	<u>3555c</u>	<u>3555d</u>	<u>3556</u>	<u>3559</u>
4. Do not run third boiler on standby unless absolutely necessary to reduce standby losses. When unoccupied period loads are less than the peak output of one boiler, only two boilers need to be operational.					X	
5. Insulate control valves and additional piping in equipment rooms.	X	X	X	X	X	
6. Clean coils and remove obstructions from around coils of walk-in cooler refrigeration equipment, to increase cooling efficiency and to improve system performance.		X				X
7. Check outside air ventilation for reduction to maintain minimum pressurization levels without excessive exhaust and resulting make-up air. Optimize existing damper controls with space pressurization.	X	X	X			
8. Adjust the quantity of steam vented from the boiler system to an 18" plume. Plumes of 3' to 4' were observed. Reducing plume height reduces energy waste.					X	
9. Consider the use of low friction synthetic oils in lieu of petroleum based oils for lubrication of air compressors	X			X		
10. Repair or replace radiator valves which cannot be shut tightly or are frozen in the open position.			X			X
11. Calibrate all HVAC distribution fan and pumping system controls to verify operation of all shutdown switches, reset temperature controls, and thermostats.	X	X		X		

<u>Project</u>	<u>Applicable Buildings</u>					
	<u>3555a</u>	<u>3555b</u>	<u>3555c</u>	<u>3555d</u>	<u>3556</u>	<u>3559</u>
12. Adjust boiler controls such as flue gas oxygen and carbon monoxide for maximum energy efficiency on a periodic basis, in addition to boiler safety inspections.	X	X		X		
13. Check and maintain steam traps on a periodic basis. Repair steam leaks.		X	X	X	X	X
14. Check and maintain compressed air system on a periodic basis. Repair system leaks.		X	X	X		X
15. Maintain heating water, chilled water and steam piping insulation.	X	X	X	X	X	X
16. Clean condenser water piping and evaporative condenser water systems through chemical treatment to improve system efficiency.			X	X		
17. Replace condenser coils or entire evaporative condenser cells serving the central ammonia refrigeration system, to increase capacity, and to reduce the quantity of make-up water wasted to the sanitary sewer.				X		
18. Optimize operation of the ice builder refrigeration equipment. Adjust controls for maximum ice thickness (2-1/2"). Provide controls to operate refrigeration compressors at night, and shut off during the day to reduce peak electrical demand charges.			X			

Electrical:

19. Replace the 40-watt lamps with energy efficient 34-watt lamps as lamps fail, as part of a maintenance program. Upgrade the standard ballast to the high efficiency type.	X	X	X	X	X	X
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<u>Project</u>	Applicable Buildings					
	<u>3555a</u>	<u>3555b</u>	<u>3555c</u>	<u>3555d</u>	<u>3556</u>	<u>3559</u>

20. Turn off lighting during non-use in administration, mechanical, dining, and storage areas. X X X X X X
21. Clean all lighting fixtures. X X X X X X
22. Implement task lighting; i.e. remove lamps or entire fixtures where not necessary. X X
23. Periodically check controls for all outdoor perimeter lights, to determine if controls have failed in the "on" position. X
24. Replace failed electric motors with high efficiency motors for motors with a horsepower of one HP or greater. X X X X X X

Table 6.1.1-LIST OF ALL ECO'S

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY
DOUBLE PANE WINDOWS	35555b	55b-B-11	136.1	0.1	119	506	9.0	199	95894
DOUBLE PANE WINDOWS	35555d	55d-B-11	448.7	0.0	6	24	0.0	0	10540
DOUBLE PANE WINDOWS	35559	59-B-11	130.3	0.1	32	136	9.0	210	45100
AIR CURTAINS	35555b	55b-M-12	1.9	9.0	3961	16834	-0.3	-7	31356
REDUCE INFILTRATION-VESTIBULE	35555c	55c-B-12	1.9	5.9	0	0	481.0	11097	21464
INSULATE OFFICE WALLS	35555b	55b-B-14.1	86.0	0.2	95	405	10.0	240	55453
INSULATE BAKERY WALLS	35555b	55b-B-14.2	63.4	0.2	604	2567	37.0	856	217152
INSULATE COLD ROOM WALLS	35555c	55c-B-14	686.9	0.0	23	97	26.0	604	482036
DOMESTIC WATER PREHEAT-HEAT PUMP	35555b	55b-M-15	0.0	0.0	8	0	0.0	0	0
DOMESTIC WATER PREHEAT-HEAT PUMP	35555c	55c-M-15	0.0	0.0	0	0	0.0	0	0
DOMESTIC WATER PREHEAT-HEAT PUMP	35555d	55d-M-15	0.0	0.0	0	0	0.0	0	0
INSTANTANEOUS ELECTRIC WATER HEATERS	35555a	55a-M-16	45.2	0.4	9	38	-0.3	-7	1414
INSTANTANEOUS ELECTRIC WATER HEATERS	35555b	55b-M-16.1	55.0	1.5	60	255	-10.0	-235	1060
INSTANTANEOUS ELECTRIC WATER HEATERS	35555b	55b-M-16.2	28.1	1.0	28	120	-4.0	-82	1060

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	GAS SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	PROJECT FUNDING CATEGORY
INSTANTANEOUS ELECTRIC WATER HEATERS	3555d	55d-N-16	0.0	0.0	0	120	0.0	0	0
REDUCE DOMESTIC HOT WATER TEMPERATURES	3555a	55a-N-17	0.0	0.0	0	0	0.0	0	0
REDUCE DOMESTIC HOT WATER TEMPERATURES	3555b	55b-N-17	0.0	0.0	0	0	0.0	0	0
REDUCE DOMESTIC HOT WATER TEMPERATURES	3555c	55c-N-17	0.0	0.0	0	0	0.0	0	0
REDUCE DOMESTIC HOT WATER TEMPERATURES	3555d	55d-N-17	0.0	0.0	0	0	0.0	0	0
INSULATE DOMESTIC HOT WATER HEATERS	3555b	55b-N-18	0.0	0.0	0	0	0.0	0	0
INSULATE DOMESTIC HOT WATER TANKS	3555c	55c-N-18	6.1	2.8	160	680	0.0	0	4157 O & M
INSULATE DOMESTIC HOT WATER TANKS	3555d	55d-N-18	0.0	0.0	0	0	0.0	0	0
FLOW RESTRICTORS	3555a	55a-N-19	0.0	0.0	0	0	0.0	0	0
FLOW RESTRICTORS	3555b	55b-N-19	0.0	0.0	0	0	0.0	0	0
FLOW RESTRICTORS	3555c	55c-N-19	0.0	0.0	0	0	0.0	0	0
FLOW RESTRICTORS	3555d	55d-N-19	0.0	0.0	0	0	0.0	0	0
INSULATE DOMESTIC HOT WATER PIPING	3555b	55b-N-20	0.0	0.0	0	0	0.0	0	0
INSULATE DOMESTIC HOT WATER PIPING	3555c	55c-N-20	6.1	2.8	42	179	0.0	0	1085 O & M

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MM_BTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY
INSULATE DOMESTIC HOT WATER PIPING	3555d	55d-M-20	0.0	0.0	0	0.0	0.0	0	0
SHUT DOWN DOMESTIC HOT WATER	3555b	55b-M-21	0.0	0.0	0	0.0	0.0	0	0
SHUT DOWN DOMESTIC HOT WATER	3555c	55c-M-21	0.0	0.0	0	0.0	0.0	0	0
SHUT DOWN DOMESTIC HOT WATER	3555d	55d-M-21	0.0	0.0	0	0.0	0.0	0	0
IMPROVE HEATING DISTRIBUTION SYSTEM	3555a	55a-M-22	0.0	0.0	0	0.0	0.0	0	0
STEAM SYSTEM MODIFICATIONS	3555b	55b-M-22	6.4	2.6	185	786	0.0	0	5059 O & M
INSULATE STEAM PIPING	3555c	55c-M-22	1.4	11.8	621	2639	0.0	0	3764 QTRP
STEAM SYSTEM MODIFICATIONS	3555d	55d-M-22	0.0	0.0	0	0.0	0.0	0	0
PROVIDE CONDENSATE RETURN	3555b	55b-M-23	7.6	1.9	303	1288	-1.0	-12	17676 NONE
PROVIDE CONDENSATE RETURN	3555c	55c-M-23	5.5	2.7	165	701	-0.2	-5	6585 O & M
REPLACE STEAM TRAPS	3555b	55b-M-24	1.3	13.2	328	1394	0.0	23	1783 O & M
REPLACE STEAM TRAPS	3555c	55c-M-24	1.3	13.2	164	697	0.0	0	891 O & M
REPLACE STEAM TRAPS	3555d	55d-M-24	0.4	40.3	842	3579	0.0	0	1498 O & M

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MBTU/yr	GAS SAVINGS \$/yr	ELECT SAVINGS MBTU/yr	ELECT SAVINGS \$/yr	PROJECT COST	FUNDING CATEGORY
CONVERT HEATING TO HOT WATER		3555a	55a-H-25	0.0	0.0	0	0.0	0	0
CONVERT HEATING TO HOT WATER		3555b	55b-H-25	0.0	0.0	0	0.0	0	0
CONVERT HEATING TO HOT WATER		3555c	55c-H-25.1	24.0	0.6	125	531	-0.1	-2
CONVERT CIP AND MIXERS TO HOT WATER		3555c	55c-H-25.2	22.8	0.7	330	1403	0.0	0
CONVERT HEATING TO HOT WATER		3555d	55d-H-25	0.0	0.0	0	0.0	0	0
CONVERT HEATING TO HOT WATER		3559	59-H-25	15.2	0.9	772	3281	51.0	1177
AIR COMPRESSORS		3555b	55b-H-26	0.0	0.0	0	0.0	0	0
HEATING THERMAL STORAGE		3555b	55b-H-27	0.0	0.0	0	0.0	0	0
HEATING THERMAL STORAGE		3555c	55c-H-27	0.0	0.0	0	0.0	0	0
HEATING THERMAL STORAGE		3555d	55d-H-27	0.0	0.0	0	0.0	0	0
PROVIDE UNIT HEATERS		3555b	55b-H-28.1	30.2	0.4	120	510	56.0	1301
SPOT HEATING		3555b	55b-H-28.2	0.0	0.0	0	0.0	0	0
INSULATE HEATING WATER PIPING		3555b	55b-H-30	0.0	0.0	0	0.0	0	0
INSULATE HEATING WATER PIPING		3555c	55c-H-30	0.0	0.0	0	0.0	0	0

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	PROJECT FUNDING CATEGORY
INSULATE HEATING WATER PIPING	3555d	55d-M-30	0.0	0.0	0	0	0.0	0	NONE
INSULATE PIPING SPECIALTIES	3556	56-M-30	5.3	3.2	189	803	0.0	0	4255 O&M
CONTROL MODIFICATIONS	3555b	55b-M-31	2.2	7.7	2706	11501	0.0	0	25253 PECIP
RADIATOR CONTROL VALVES	3555c	55c-M-31	4.2	4.0	133	565	0.0	0	2380 O&M
IMPROVE TEMPERATURE CONTROLS	3555d	55d-M-31	0.0	0.0	0	0	0.0	0	NONE
RADIATOR CONTROL VALVES	3559	59-M-31	3.4	4.2	386	1641	82.0	1894	11897 PECIP
ROOF VENTILATION FANS	3555b	55b-M-33.1	4.4	2.6	0	0	714.0	16472	70880 NONE
DA CONTROL DAMPERS	3555b	55b-M-33.2	4.9	3.4	462	1964	0.0	0	9708 O&M
REPLACE AIR HANDLING SYSTEM	3555b	55b-M-35.1	0.0	0.0	0	0	0.0	0	NONE
THERMAL STORAGE	3555b	55b-M-35.2	21.8	0.5	0	0	-83.0	-1913	325325 NONE
REFRIGERANT PUMPS	3555b	55b-M-35.3	2.6	4.4	0	0	612.0	14119	35609 PECIP
PROCESS EVAPORATIVE COOLER	3555c	55c-M-35.1	1.9	6.3	0	0	-77.0	-1774	41330 GRIP
NEW HTST HEAT EXCHANGER	3555c	55c-M-35.2	0.0	0.0	0	0	0.0	0	NONE
NEW REFRIGERATION CENTRAL CONTROL	3555c	55c-M-35.3	3.5	3.3	-1	-6	3091.0	71309	283909 ECIP

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	STC SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY
CYCLE REFRIGERATION SPACE COOLERS	3555c	55c-H-35.4	0.8	13.8	-27	-113	2501.0	57698	47880 QRIP
REFRIGERATION EVAPORATIVE COOLER	3555c	55c-H-35.5	0.3	35.8	0	0	0.0	0	34458 NONE
CHILLED BRINE REFRIGERATION SYSTEM	3555c	55c-H-35.6	63.1	0.2	0	0	531.0	12250	690712 NONE
INSULATE REFRIGERATION COMPRESSORS	3555c	55c-H-35.7	1.7	6.7	0	0	138.0	3184	5450 QRIP
NEW REFRIGERATION INTERCOOLER	3555c	55c-H-35.8	1.1	10.9	1942	44802	1942.0	44802	47229 QRIP
THREE STAGE REFRIGERATION	3555c	55c-H-35.9	0.0	0.0	0	0	0.0	0	0 NONE
HARDENING TUNNEL	3555c	55c-H-35.10	0.0	0.0	0	0	0.0	0	0 NONE
NEW REFRIGERATION OIL SEPARATOR	3555c	55c-H-35.11	1.0	11.2	0	0	270.0	6229	6395 QRIP
HVAC COOLING SYSTEM MODIFICATIONS	3555d	55d-H-35	3.3	3.4	0	0	165.0	3807	12043 PECIP
REPLACE REFRIGERATION EQUIPMENT	3559	59-H-35	66.3	0.2	0	0	73.0	1684	111668 NONE
INSULATE COOLING SYSTEM PIPING	3555b	55b-H-36	0.0	0.0	0	0	0.0	0	0 NONE
INSULATE COOLING SYSTEM PIPING	3555d	55d-H-36	0.0	0.0	0	0	0.0	0	0 NONE
DOMESTIC WATER PREHEAT-DESUPERHEATERS	3555b	55b-H-37.1	5.6	3.1	1619	6981	-7.0	-152	36007 NONE
DOMESTIC WATER PREHEAT-AIR COMPRESSORS	3555b	55b-H-37.2	8.1	2.3	893	3795	-30.0	-699	24377 NONE

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	SIR	GAS SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY
OVEN CONTROLS	3555b	55b-H-37.3	7.2	1.7	282	1286	268.0	6183	146661	NONE
OVEN HEAT RECOVERY-HEAT DOMEST. HOT WATER	3555b	55b-H-37.4	17.3	1.0	3917	16647	-65.0	-1500	251579	NONE
OVEN HEAT RECOVERY-HEAT THE BAKERY	3555b	55b-H-37.5	20.3	0.9	3480	14790	-65.0	-1500	261563	NONE
DOMESTIC WATER PREHEAT-DESUPERHEATERS	3555b	55b-H-37.6	3.8	4.5	810	3443	0.0	0	12705	PECIP
REFRIGERATION HEAT RECOVERY-DOMESTIC WATER	3555c	55c-H-37	10.8	1.6	2037	8657	0.0	0	91751	NONE
REDUCE STRATIFICATION	3555b	55b-H-38.1	6.7	2.2	230	978	38.0	870	11855	NONE
TRANSFER FAN	3555b	55b-H-38.2	10.7	1.3	112	476	21.0	494	9489	NONE
INCINERATOR	3555b	55b-H-39	0.0	0.0	0	0	0.0	0	0	NONE
SURFACE BLOWDOWN HEAT RECOVERY	3556	56-H-40	13.6	1.2	325	1380	0.0	0	18703	NONE
ENERGY EFFICIENT SMALL BOILER	3556	56-H-44.1	31.4	0.5	489	2078	42.0	957	118637	NONE
BOILER CONTROL MODIFICATIONS	3556	56-H-44.2	5.7	2.2	496	2108	0.0	0	63484	NONE
PROVIDE OCCUPANCY SENSOR-LIGHTING CONTROL	3555a	55a-E-45.1	10.3	1.1	0	0	29.0	678	6973	NONE
PROVIDE TIME CLOCKS-LIGHTING CONTROL	3555a	55a-E-45.2	7.9	1.5	0	0	29.0	678	5378	0 & N
PROVIDE TIMECLOCK LTC. CONTROLS	3555b	55b-E-45.1	1.5	7.3	-137	-502	309.0	7129	9812	QRP

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MMBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY
PROVIDE PROGRAMMABLE LT6. CONTROLS	3555b	55b-E-45.2	5.8	2.0	-34	-145	319.0	7359	42152
PROVIDE TIMECLOCK LIGHT CONTROLS	3555c	55c-E-45.1	0.0	0.0	0	0	0.0	0	0
PROVIDE PROGRAMMABLE LT6. CONTROLS	3555c	55c-E-45.2	0.0	0.0	0	0	0.0	0	0
PROVIDE TIMECLOCK LT6. CONTROLS	3555d	55d-E-45.1	0.0	0.0	0	0	0.0	0	0
PROVIDE PROGRAMMABLE LT6. CONTROLS	3555d	55d-E-45.2	0.0	0.0	0	0	0.0	0	0
REDUCE LAMPING ADD TASK LT6.	3555a	55a-E-46.1	0.0	0.0	0	0	0.0	0	0
REPLACE EXISTING BALLASTS-IMPROVE EFF.	3555a	55a-E-46.2	37.6	0.3	0	0	19.0	427	16043
LOWER LIGHT FIX.-REPL. BALLAST	3555b	55b-E-46	13.1	0.9	-34	-143	473.0	10912	141054
REPLACE BALLASTS	3555c	55c-E-46	0.0	0.0	0	0	0.0	0	0
REPLACE BALLASTS	3555d	55d-E-46	0.0	0.0	0	0	0.0	0	0
IMPROVE INTERIOR LIGHT EFFICIENCY	3555e	56-E-46	0.0	0.0	0	0	0.0	0	0
PROVIDE PHOTO-ELECTRIC DIMMING	3555a	55a-E-47	0.0	0.0	0	0	0.0	0	0
REPLACE FLOUR. BALLASTS - ADD TIMERS	3555b	55b-E-47	2.4	4.6	-231	-982	517.0	11927	26161 PECIP
REPLACE FLOUR. BALLASTS - ADD TIMERS	3555c	55c-E-47	0.0	0.0	0	0	0.0	0	0

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS \$/YR	GAS SAVINGS MM BTU/YR	ELECT SAVINGS \$/YR	ELECT SAVINGS MM BTU/YR	PROJECT COST	FUNDING CATEGORY
REPLACE FLUOR. BALLASTS - ADD TIMERS	3555d	55d-E-47	0.0	0.0	0	0.0	0	0	NONE
CONTROL LIGHT LEVELS AUTOMATICALLY	3555e	56-E-47	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH MERCURY	3555b	55b-E-49.1	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH MERCURY	3555c	55c-E-49.1	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH MERCURY	3555d	55d-E-49.1	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH HP SODIUM	3555b	55b-E-49.2	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH HP SODIUM	3555c	55c-E-49.2	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH HP SODIUM	3555d	55d-E-49.2	0.0	0.0	0	0.0	0	0	NONE
REPLACE MANUAL FLUOR WITH AUTO HALIDE	3555b	55b-E-49.3	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH METAL HALIDE	3555c	55c-E-49.3	0.0	0.0	0	0.0	0	0	NONE
REPLACE FLUORESCENT WITH METAL HALIDE	3555d	55d-E-49.3	0.0	0.0	0	0.0	0	0	NONE
PEAK DEMAND SHEDDING	3555	55-E-54	0.0	0.0	0	0.0	0	0	NONE
PEAK LOAD SHEDDING	3555b	55b-E-54	0.0	0.0	0	0.0	0	0	NONE
PEAK LOAD SHEDDING	3555c	55c-E-54	0.0	0.0	0	0.0	0	0	NONE

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MBTU/YR	GAS SAVINGS \$/YR	ELECT SAVINGS MBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY
PEAK LOAD SHEDDING	3555d	55d-E-54	0.0	0.0	0	0	0.0	0	NONE
PROVIDE SOLID-STATE MOTOR STARTERS	3555b	55b-E-55.1	0.0	0.0	0	0	0.0	0	NONE
PROVIDE CAPACITORS NEAR MOTORS	3555b	55b-E-55.2	0.0	0.0	0	0	0.0	0	NONE
PROVIDE SOLID-STATE MOTOR STARTERS	3555c	55c-E-55.1	0.0	0.0	0	0	0.0	0	NONE
PROVIDE CAPACITORS NEAR MOTORS	3555c	55c-E-55.2	71.7	0.2	0	0	0.0	0	32103 NOne
PROVIDE SOLID-STATE MOTOR STARTERS	3555d	55d-E-55.1	0.0	0.0	0	0	0.0	0	NONE
PROVIDE CAPACITORS NEAR MOTORS	3555d	55d-E-55.2	0.0	0.0	0	0	0.0	0	NONE
REPLACE MOTORS - VARIABLE FREQ. DRIVES	3555b	55b-E-56	0.0	0.0	0	0	0.0	0	NONE
REPLACE MOTORS - VARIABLE FREQ. DRIVES	3555c	55c-E-56	0.0	0.0	0	0	0.0	0	NONE
REPLACE MOTORS - VARIABLE FREQ. DRIVES	3555d	55d-E-56	0.0	0.0	0	0	0.0	0	NONE
IMPROVE SITE LIGHTING EFFICIENCY	SITE	01-E-48	0.0	0.0	0	0	0.0	0	NONE
IMPROVE ELECTRICAL DISTRIBUTION	SUB.#1	01-E-52.1	0.0	0.0	0	0	0.0	0	NONE
IMPROVE ELECTRICAL DISTRIBUTION	SUB.#2	01-E-52.2	0.0	0.0	0	0	0.0	0	NONE
IMPROVE ELECTRICAL DISTRIBUTION	SUB.#3	01-E-52.3	0.0	0.0	0	0	0.0	0	NONE

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SIR	GAS SAVINGS \$/YR	ELECT SAVINGS \$/YR	PROJECT COST	FUNDING CATEGORY
IMPROVE ELECTRICAL DISTRIBUTION								
PEAK DEMAND SHEDDING	SUB. #4	01-E-52.4	0.0	0.0	0	0.0	0	0
PEAK DEMAND SHEDDING	SUB. #11	01-E-54.1	0.0	0.0	0	0.0	0	0
PEAK DEMAND SHEDDING	SUB. #2	01-E-54.2	0.0	0.0	0	0.0	0	0
PEAK DEMAND SHEDDING	SUB. #3	01-E-54.3	0.0	0.0	0	0.0	0	0
PEAK DEMAND SHEDDING	SUB. #4	01-E-54.4	0.0	0.0	0	0.0	0	0
COGENERATION - STEAM TURBINE	SITE	01-ME-58.1	0.0	0.0	0	0.0	0	0
COGENERATION - GAS TURBINE	SITE	01-ME-58.2	6.4	1.1	-27300	-116025	12300.0	283761
							950182	NONE

* FUNDING CATEGORY, BASED UPON FY 1992.
NONE - NOT ECONOMICALLY FEASIBLE, NOT RECOMMENDED FOR IMPLEMENTATION.

0 \$ N - LOW COST PROJECT, OWNER FINANCED.

QRP - QUICK RETURN ON INVESTMENT PROGRAM.

PECIP - PRODUCTIVITY ENHANCING CAPITAL INVESTMENT PROGRAM.

OSD - OFFICE OF THE SECRETARY OF DEFENSE PRODUCTIVITY INVESTMENT FUNDING.
ECIP - ENERGY CONSERVATION INVESTMENT PROGRAM.

SECTION 7

ENERGY AND COST SAVINGS

- 7.1 TOTAL ECO SAVINGS
- 7.2 PROJECTED ANNUAL UTILITY COSTS
- 7.3 BREAKDOWN OF PROJECTED ENERGY COSTS

7.1 TOTAL ECO SAVINGS

The net interaction savings of utilities and maintenance were determined for the recommended ECO's. Sometimes several different ECO's will provide duplicate energy savings. Also, as projects with higher priority are implemented, the energy savings of other projects lower on the list may be reduced. Some ECO's will become economically unfeasible when implemented with other ECO's. For these reasons, interaction plays an important part in implementation of ECO's. The net savings are indicated in Table 7.1.1.

The total utility savings offered by all economically feasible ECO's are listed in Table 7.1.1. Also listed are maintenance savings. The results show an overall net reduction of 16,489 MMBTU/YR. This amounts to a 13% savings in energy over the facility utility bills. Total annual cost savings is 16.2%.

7.2 PROJECTED ANNUAL UTILITY COSTS

Table 7.1.1 indicates the annual costs of electricity, boiler gas, bakery gas, and water before and after implementation of ECO's. This data was used for the graph of Figure 7.2.1. This figure indicates that the most potential for cost savings falls under electrical usage. In addition, most energy savings due to economically feasible ECO's apply to electrical usage.

7.3 BREAKDOWN OF PROJECTED ENERGY COSTS

Table 7.1.1 also indicates the energy usage and savings for each major energy user. The energy usage values establish the maximum amount of energy which can be saved in each category. This data was used for the graph of Figure 7.3.1. The Figure shows where most of the energy is currently used and how much of the energy costs can be reduced by implementing ECO's. It is apparent that although plenty of heat recovery opportunities exist for generation of domestic hot water, the potential for energy savings are minimal when compared with the refrigeration and process equipment.

TABLE 7.1.1 - TOTAL ENERGY SAVINGS

CURRENT BASELINE ENERGY USAGE				PROPOSED ENERGY USAGE			
MAJOR USER	MMBTU/YR	\$/MMBTU	\$/YR USAGE	ECO SAVINGS MMBTU/YR	ECO SAVINGS \$/YR	\$/YR USAGE	% \$ SAVED
1 REFRIGERATION	23,010	23.07	530,841	8,423	194,319	336,522	36.6
2 HVAC FANS & AUX	6,335	23.07	146,148	777	17,925	128,223	12.3
3 LIGHTING	5,942	23.07	137,082	338	7,798	129,284	5.7
4 EQUIPMENT PROCESS	9,143	23.07	210,929	-77	-1,776	212,705	-0.8
5 OTHER FACIL ELECT	6,580	23.07	151,801	0	0	151,801	0.0
6 SPACE HEATING	11,170	4.25	47,473	3,707	15,755	31,718	33.2
7 DOMESTIC HW	3,270	4.25	13,898	1,177	5,002	8,895	36.0
8 STEAM PROCESS	31,520	4.25	133,960	2,144	9,112	124,848	6.8
9 OTHER FACIL GAS	6,820	4.25	28,985	0	0	28,985	0.0
10 BAKERY GAS	20,210	4.56	92,158	0	0	92,158	0.0
11 WATER	-	-	189,100	-	24,708	164,392	13.1
12 MAINTENANCE	-	-	-	-	9,547	-	-
3 YEAR AVG, FY 86-88		124,000					
ELECTRIC POWER	51,010	23.07	1,176,801	9,461	218,265	958,535	18.5
BOILER GAS	52,780	4.25	224,315	7,028	29,889	194,446	13.3
BAKERY GAS	20,210	4.56	92,158	0	0	92,158	0.0
WATER	-	-	189,100	0	24,708	164,392	13.1
TOTAL	124,000		1,682,373	16,489	272,842	1,409,531	16.2

FIGURE 7.2.1 - PROJECTED ANNUAL UTILITY COSTS

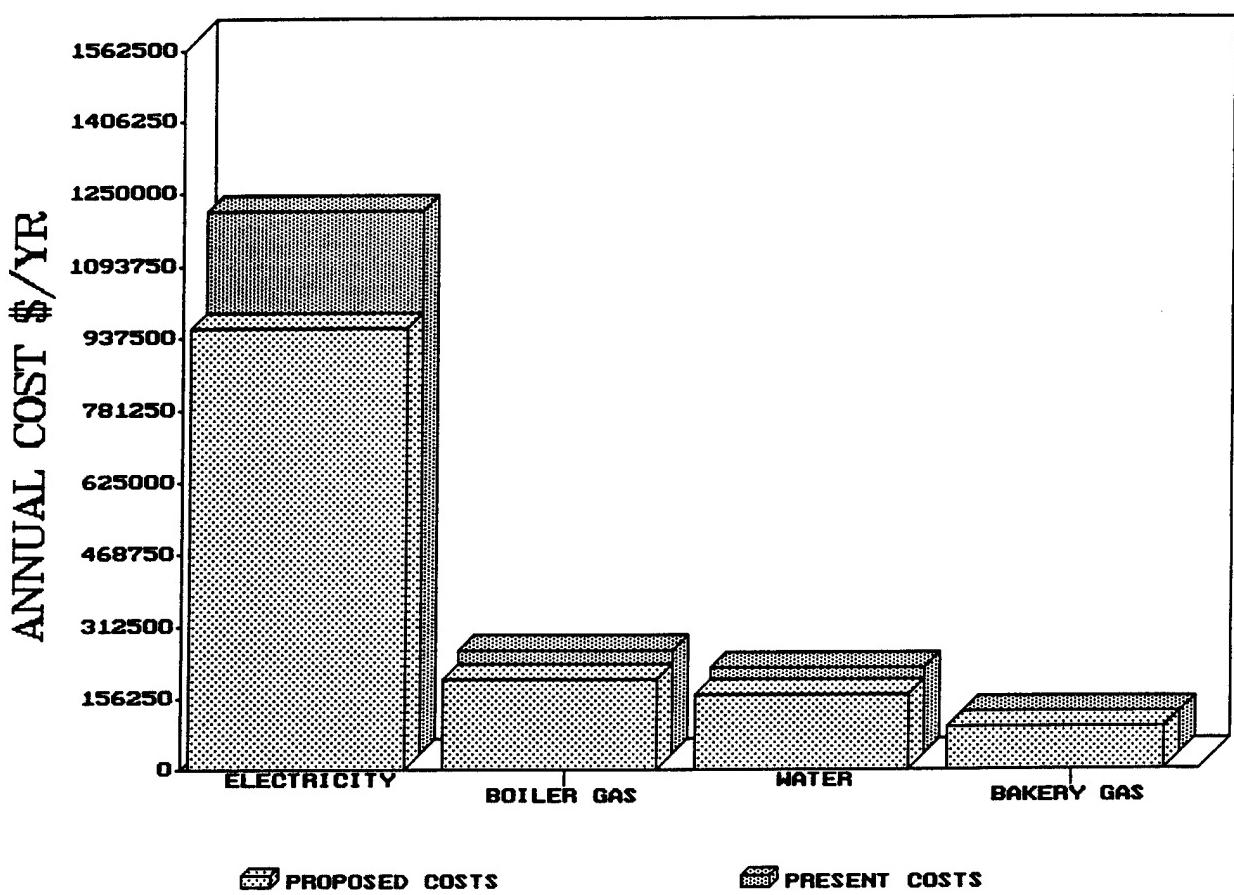
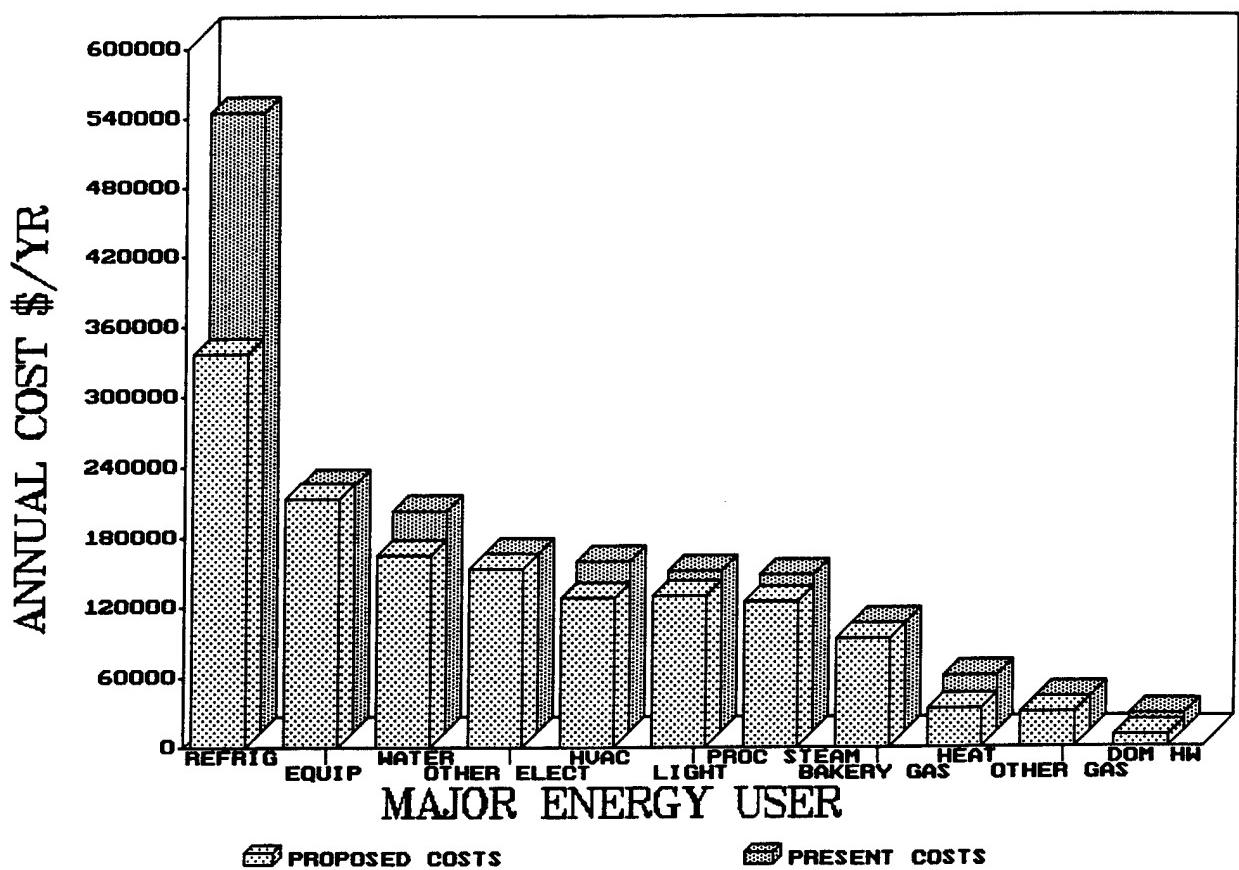


FIGURE 7.3.1 - PROJECTED ANNUAL ENERGY COSTS



SECTION 8

ENERGY PLAN

- 8.1 PROJECT FUNDING CRITERIA
- 8.2 LIST OF RECOMMENDED ECO's

8.1 PROJECT FUNDING CRITERIA

Projects are recommended for funding if the savings show a simple payback of under 4 years and an SIR over 1. The economically feasible ECO's recommended for implementation in FY 1992. These ECO's fall under one of the following Categories.

O & M: Low cost projects which are anticipated to be funded entirely by the user. Some of these projects do not qualify for other programs due to a payback higher than 4 years.

QRIP: Quick Return on Investment Program.

PECIP: Productivity Enhancing Capital Investment Program.

OSD PIF: Office of the Secretary of Defense Productivity Investment Funding.

ECIP: Energy Conservation Investment Program.

Due to the limited availability of construction funds, projects with slightly higher paybacks, and initial cost less than \$10,000 are recommended to be financed by operating personnel (indicated as O & M above). The use of operating personnel can substantially reduce project cost by eliminating labor and material mark-ups.

All project funding documentation for the ECO's recommended for implementation, are bound separately in the volume titled "Programming Documentation".

8.2 LIST OF RECOMMENDED ECO's

Table 8.2.1 lists all recommended ECO's, ranked in order of highest to lowest SIR, in accordance with the funding category (O & M, QRIP, PECIP, OSD PIF, or ECIP).

Table 8.2.1 LIST OF RECOMMENDED ECO'S - PRIORITIZED

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS \$/YR	ELECT SAVINGS \$/YR	PROJECT COST \$/YR	FUNDING CATEGORY	TOT ENERGY SAVINGS \$/YR	NON-ENERGY SAVINGS \$/YR	TOTAL SAVINGS \$/YR
CYCLE REFRIGERATION SPACE COOLERS	3555c	55c-M-35.4	0.8	13.8	-27	-113	2501.0	57698	47880	QRIP
INSULATE STEAM PIPING	3555c	55c-M-22	1.4	11.8	621	2639	0.0	0	3764	QRIP
NEW REFRIGERATION OIL SEPARATOR	3555c	55c-M-35.11	1.0	11.2	0	0	270.0	6229	6395	QRIP
NEW REFRIGERATION INTERCOOLER	3555c	55c-M-35.8	1.1	10.9	1942	44802	1942.0	44802	47229	QRIP
PROVIDE TIMECLOCK LT6. CONTROLS	3555b	55b-E-45.1	1.5	7.3	-137	-582	309.0	7129	9812	QRIP
INSULATE REFRIGERATION COMPRESSORS	3555c	55c-M-35.7	1.7	6.7	0	0	138.0	3184	5450	QRIP
PROCESS EVAPORATIVE COOLER	3555c	55c-M-35.1	1.9	6.3	0	0	-77.0	-1774	41330	QRIP
REDUCE INFILTRATION-VESTIBULE	3555c	55c-B-12	1.9	5.9	0	0	481.0	11097	21464	QRIP
CONTROL MODIFICATIONS	3555b	55b-M-31	2.2	7.7	2706	11501	0.0	0	25253	PECIP
REPLACE FLOOR. BALLASTS - ADD TIMERS	3555b	55b-E-47	2.4	4.6	-231	-982	517.0	11927	26161	PECIP
DOMESTIC WATER PREHEAT-DESUPERHEATERS	3555b	55b-M-37.6	3.8	4.5	810	3443	0.0	0	12705	PECIP
REFRIGERANT PUMPS	3555b	55b-M-35.2	2.6	4.4	0	0	612.0	14119	35609	PECIP
RADIATOR CONTROL VALVES	3555b	59-M-31	3.4	4.2	386	1641	82.0	1894	11897	PECIP
HVAC COOLING SYSTEM MODIFICATIONS	3555d	55d-M-35	3.3	3.4	0	0	165.0	3807	12043	PECIP

ECO TITLE	BLDG.	ECO NUMBER	SIMPLE PAYBACK YEARS	GAS SAVINGS MMBTU/YR	ELECT SAVINGS \$/YR	PROJECT COST \$/YR	FUNDING CATEGORY	TOT ENERGY SAVINGS \$/YR	TOTAL SAVINGS \$/YR
REPLACE STEAM TRAPS	3555d	55d-M-24	0.4	40.3	842	3579	0.0	0	1498
REPLACE STEAM TRAPS	3555c	55c-M-24	1.3	13.2	164	697	0.0	0	891
REPLACE STEAM TRAPS	3555b	55b-M-24	1.3	13.2	328	1394	0.0	23	1783
RADIATOR CONTROL VALVES	3555c	55c-M-31	4.2	4.0	133	565	0.0	0	2380
0A CONTROL DAMPERS	3555b	55b-M-33.2	4.9	3.4	462	1964	0.0	0	9708
INSULATE PIPING SPECIALTIES	3555b	56-M-30	5.3	3.2	189	803	0.0	0	4255
INSULATE DOMESTIC HOT WATER PIPING	3555c	55c-M-20	6.1	2.8	42	179	0.0	0	1085
INSULATE DOMESTIC HOT WATER TANKS	3555c	55c-M-18	6.1	2.8	160	680	0.0	0	4157
PROVIDE CONDENSATE RETURN	3555c	55c-M-23	5.5	2.7	165	701	-0.2	-5	6585
STEAM SYSTEM MODIFICATIONS	3555b	55b-M-22	6.4	2.6	185	786	0.0	0	5059
PROVIDE TIME CLOCKS-LIGHTING CONTROL	3555a	55a-E-45.2	7.9	1.5	0	0	29.0	678	5378
NEW REFRIGERATION CENTRAL CONTROL	3555c	55c-M-35.3	3.5	3.3	-1	-6	3091.0	71309	283909
							ECIP	71303	10400
									81703

SECTION 9

CONCLUSIONS

9.1 CONCLUSIONS

9.1 CONCLUSIONS

A total of 147 energy conservation opportunities (ECO's) were evaluated for the buildings studied at this facility. Of these ECO's, 15 projects were found to be economically feasible.

An ECO is considered to be economically feasible if it has an SIR greater than 1, and if it has a simple payback of 4 years or less. An additional 11 ECO's with slightly higher paybacks, and which do not qualify for funding, are recommended to be done by facility operating personnel.

The annual utility costs for the facility are as follows:

Electricity	\$1,176,801
Natural Gas	\$ 316,473
Water	\$ 189,100
Total	\$1,682,374

Implementation of all economically feasible ECO's, including ECO's which can be done by facility operating personnel will reduce utility costs by \$272,842 per year. This is a 16.2% reduction in overall utility costs.

The total initial cost of these recommended ECO's is \$633,680.